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A DISCUSSION OF SOME VICTORIAN ORDOVICIAN GRAPTOLITES

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Abstract

Type specimens of some Australian, primarily Victorian, Ordovician graptolites housed in the National Museum of Victoria have been examined and the species based on them discussed. Fourteen of the seventeen species considered are described more fully than they had been, and all are illustrated for the first time photographically. *Pseudoclimacograptus* cf. *P. scharenbergi* is described. The more complete descriptions of the types and detailed comparisons of them with closely related forms in other parts of the world permitted recognition that some of the species considered are unique to Australia, others to Australia and New Zealand, but that others are widely-spread. Because many of the Victorian Ordovician graptolites are reported to occur in New Zealand, China, Russia, and North America, closest and most detailed comparisons were made with forms in those areas.

Victorian type specimens of *Climacograptus bicornis* subspecies *longispina* and *Paraglossograptus etheridgei* appear to have comprised a local population and a subspecies respectively that are distinct from those comprised of North American specimens of these forms. *Climacograptus riddellensis, Didymograptus v-deflexus, Phyllograptus nobilis,* and *Retiograptus pulcherrimus,* on the other hand, scarcely differ at all when American specimens and the Victorian types of these species are closely compared. Similarly, Victorian specimens of *Orthograptus truncatus* var. *abbreviatus* are closely similar to British specimens.

Convergence in thecal apertural excavation shape in two phyletic lineages of climacograptids was also noted. The apertural excavations in *Climacograptus riddellensis* have the same shape as those in *Pseudoclimacograptus angulatus* and some other pseudoclimacograptids.

Introduction

The National Museum of Victoria houses some of the oldest Australian graptolite collections which include many widely-cited species. A few of the graptolites in the collections were described by Sir Frederick McCoy in the latter part of the 1800s in the course of his monumental palaeontological study which culminated in the *Prodromus of the Palaeontology of Victoria.* Others of the specimens were studied by T. S. Hall just before and after the turn of the century and by W. H. Harris and R. A. Keble during the 1920s and 1930s. Several new species were delineated by these palaeontologists over the years from the materials in the National Museum's graptolite collections. Accordingly, several types are to be found in them.

With few exceptions, the only published figures of the types are line drawings, most of which were reproduced in publication without magnification. Others, though magnified in publication, had only approximate or no magnification at all indicated with the published figure. Such reproduction of graptolite illustrations makes observation of anything more than rhabdosome form from them very difficult. Further, the descriptions of many of the species, although perfectly adequate in terms of the taxonomic work being carried on at the time they were described, are neither as precise nor as complete as they should be for detailed inquiry into phyletic and zoogeographic relationships and species structures being carried out at present.

An examination was undertaken, therefore, of some type specimens in the National Museum's graptolite collections to make the species founded upon them known more fully. All type specimens of each of the species studied in the course

of this investigation were considered in forming the descriptions given herein. If additional topotypical specimens were present in the Museum collections, they have been included in the descriptions. Some of the original localities were visited and, where possible, collections made. Topotypical specimens so obtained have been included in the consideration of the species described here. Topotypes of some of the species described are in the Geological Survey of Victoria's collections. They, too, have been included in this discussion. Most of the photographs were taken at magnifications of × 3 or greater and have been reproduced here to provide a more accurate pictorial record of the species considered than has heretofore been published.

Although in most cases other Victorian specimens of the species discussed have been examined, only the types and associated specimens from the locality from which the types were obtained are described herein. The description of each species presented here is not a full delineation of that species in Victoria or in Australia generally, but it is as complete a description as possible of the type specimens available. These descriptions might be considered those of the local populations of the species, or perhaps subspecies in some instances, at the locality from which the type specimens were collected.

The study of the Victorian specimens was carried out at the National Museum of Victoria. That of some of the Marathon Region, Texas, forms most closely comparable with the Victorian types redescribed here was accomplished at the Yale Peabody Museum with the photographs and descriptions of the Victorian specimens in hand. Where possible, other extra-Australian records of the species redescribed were considered and the specimens compared with the Victorian material to enable some tentative conclusions concerning possible subspecific, infrasubspecific, and zoogeographic relationships to be drawn.

Acknowledgements

The author is indebted to Mr John McNally, Director of the National Museum of Victoria, Melbourne for permission to study the Museum's graptolite collections and to Mr Edmund D. Gill, Assistant Director, for his considerable assistance in locating type specimens, advice on stratigraphic and taxonomic problems, and interest and encouragement in the study. The author thanks Dr John A. Talent and Mr Neil McLaurin for acquainting him with the Ordovician stratigraphy in the area about Melbourne and for taking him to many of the old Victorian graptolite localities and collecting from them with him. The author is also indebted to Dr Talent and Mr T. A. Darragh for careful reading of the manuscript. Mr H. O. Fletcher of The Australian Museum, Sydney, granted permission to the author to study the graptolite collections in that museum, and Dr Karl Waage of the Yale Peabody Museum, New Haven, Connecticut permitted restudy of the Marathon Region, Texas graptolites housed in that museum. Dr Talent facilitated examination of a considerable portion of the graptolite collections made by the Geological Survey of Victoria.

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Some Results of the Study

Complete delineation of many of the Victorian graptolite species is becoming increasingly important as detailed comparisons of them are made with Chinese, Russian, and American forms. The general features of the diagnostic associations of

Australian, Chinese, Russian, and American Ordovician graptolites have led to the recognition that an Australian-American (Berry 1960a) or, more broadly and definitely, a Pacific Faunal Region (Mu 1963) was in existence during much, if not all, of Ordovician time. The Pacific Faunal Region is most clearly revealed by comparison of the graptolite genera and species which comprise the diagnostic congregations that typify each of the Ordovician graptolite Zones in each area.

Within the context of the Faunal Region many species may be recognized that were widely-spread throughout it and had local populations in different places in it. Other species were more restricted in their distribution, and aggregates of them suggest that Provinces were in existence within the Region for most of the Ordovician.

As further inquiry delves into the ultimate faunal relationships within the Ordovician Pacific Province based upon graptolites, very precise delineation of species and their local populations are requisite for exact comparisons and contrasts to be drawn. Many of the Australian species described years ago are thus in need of restudy to enable the comparisons and contrasts to be made. A few of the types of them are redescribed here.

One result of this restudy is the recognition that a temporal subspecies of *Climacograptus bicornis, C. bicornis* subsp. *longispina,* includes two local populations. One may be recognized in the western United States on the basis of specimens obtained from two localities in Nevada, and the other is based upon specimens from an old locality near the New South Wales-Victoria border, Stockyard Creek in Wellesley County, New South Wales. The Nevada specimens, as discussed herein, are slightly wider and have slightly more thecae than the Australian specimens. All other characters of both sets of specimens are either identical or fall within the same range in variation. The degree of difference between the two groups appears to be of the order of magnitude of that between local populations. Species associated with both groups indicate that they were restricted to the latest Ordovician and were, as closely as may be ascertained from analysis of fossil data, in existence during the same span of time.

C. bicornis subsp. *longispina* is clearly a close relative of *C. bicornis senso stricto* but its spines have a characteristic outward and downward curvature to form an approximate semicircle whereas those in *C. bicornis ss.* are nearly straight and much shorter. Rhabdosomes of *C. bicornis* subsp. *longispina* are also slightly shorter and thinner than those of *C. bicornis ss.* The degree of morphologic difference between the two forms is considered to be that of a subspecies, and as specimens of *C. bicornis* subsp. *longispina* occur in strata younger than those in which *C. bicornis ss.* does, it is concluded to be a temporal subspecies of that plexus of forms that may be grouped within the species *C. bicornis.*

Another comparison made in this study revealed that specimens of *Paraglossograptus etheridgei* recognized in the Marathon Region, Texas (Berry 1960b) are, as a group, slightly thinner than the typical Victorian specimens and appear to comprise a distinct subspecies. The Marathon Region, Texas specimens of *Didymograptus v-deflexus, Climacograptus riddellensis, Phyllograptus nobilis,* and *Retiograptus pulcherrimus* are, on the other hand, so similar in all characteristics to the Victorian type specimens that the Texas and Victorian members of these species do not appear to differ even to the degree of local populations.

Victorian specimens of *Orthograptus truncatus* var. *abbreviatus* and *Pseudoclimacograptus* cf. *P. scharenbergi* are very similar to British and Scandinavian specimens respectively of these forms. Indeed, some British and Victorian specimens of *O. truncatus* var. *abbreviatus* are almost identical in every respect. Both of

these forms appear in the Paeifie faunal Region and in one or more other Regions, indicating that, as is true of the present-day distribution of organisms, not all species are restricted to one biogeographie area. Indeed, as many as 50% of the species in one area may oeeur in others as is indieated by Ekman's (1953) eomprehensive survey of zoogeographic distribution in the seas. The Vietorian and Seandinavian specimens of *Pseudoclimacograptus* ef. *P. scharenbergi* may comprise a temporal subspeeics of *P. scharenbergi*, or the Vietorian material may itself represent a distinet subspecies.

Two of the speeies studied (*Didymograptus hemicyclus* and *Diplograptus ingens*) are restrieted to the Australian portion of the Paeifie Region and do not appear to have any elosely related species outside of it. At least four other species studied (*Adelograptus clarki, Didymograptus dependulus, Didymograptus mundus,* and *Didymograptus pritchardi*) are known only from New Zealand and Vietoria. This evidenee suggests that at least a part of Australia and New Zealand may have comprised a faunal Province whieh was distinet from others in the Pacifie faunal Region during at least a part of the Ordovieian. Examination of the geographie ranges of other Victorian Ordovieian species tends to substantiate this view but eomprehensive study of all Australian and New Zealand speeies of Ordovieian graptolites must be earried out before this suggestion may be considered anything more than that.

One other result of this study has been the recognition of convergenee in theeal apertural exeavation shape in two different phyletie lineages of climaeograptids. Thecal apertural exeavations in some speeies of the genus *Pseudoclimacograptus* (*P. angulatus*, for example) are poueh-shaped. The theeal apertural excavations in *Climacograptus riddellensis* are similar in shape, but *C. riddellensis* cannot be ineluded in the genus *Pseudoclimacograptus* when all characteristics are eonsidered. Pseudoelimacograptids appear to have developed from the *Glyptograptus austrodentatus* group of glyptograptids which have streptoblastie proximal end development through more marked sigmoidal eurvature of the thceae. *C. riddellensis* appears to be allied with those elimaeograptids with prosoblastie proximal end development, straight median septa, and straight supragenieular portions of the ventral thecal walls. This climacograptid group apparently developed from the *Glyptograptus dentatus* stoek in whieh proximal end development is prosoblastie and eurvature of the ventral thecal walls not quite so marked as in the *G. austrodentatus* group.

The poueh-shaped apertural excavations apparently gave a degree of isolation to each zooid in the eolony. Sueh isolation eould have afforded some proteetion from predators. Whether this particular form of theeal apertural exeavation has any adaptive significance for certain environmental situations eannot be aseertained either from the type of deposits in whieh the speeies oeeur that have it or from the speeies associated with them. It may have some adaptive significanee or it may be merely a reflection of the general tendeney among many graptoloids toward apertural isolation.

Systematic Palaeontology

The taxonomie categories followed herein are those used by Bulman (1955) in the Ameriean *Treatise on Invertebrate Paleontology, Part V* and his subsequent (1963a) discussion of the higher-level taxonomie units. Many of the genera recognized within the Class Graptolithina are probably structural morphologic grades and not clades. Few phyletie lineages are known among the graptolites and many of the generic and subgenerie terms that have been proposed commonly apply to forms that have attained a certain degree of morphologie similarity but belong to

different phyletic lineages. More study using all the morphologic characters available needs to be carried out among the graptolites before a classification which reflects phylogeny to any great extent can be established.

The morphologic terms used herein are primarily those cited by Bulman (1955) in the American *Treatise on Invertebrate Paleontology*. In addition, the terminology proposed by Jaanusson (1960, p. 304) for portions of the thecal walls in climacograptid and amplexograptid thecal types and that suggested by Bulman (1963b, p. 671) for the types of diplograptid proximal end development are used.

Most of the type numbers are those of the National Museum of Victoria. The initials NMV are used in the descriptions and plate captions as an abbreviation for National Museum of Victoria.

Only selected synonymies have been given for each species discussed. The references cited in the synonymies are, in adition to the original, those in which specimens the author has examined are described or figured, or those in which the figures and descriptions are sufficiently precise and complete to permit relatively accurate comparisons.

Class GRAPTOLITHINA Bronn 1846

Order DENDROIDEA Nicholson 1872

Family ANISOGRAPTIDAE Bulman 1950

Genus **Adelograptus** Bulman 1941

DISCUSSION: Bulman (1941) restricted those dendroid graptolites with three primary stipes, pendent to declined rhabdosome form, and primarily lateral stipes irregularly developed to the genus *Bryograptus*. He erected the new genus *Adelograptus* to encompass those dendroid graptolites with relatively similar rhabdosome form and branching characteristics but with only two primary stipes. The two Victorian species placed herein the genus *Adelograptus* are dendroid graptolites with two primary stipes and the rhabdosome form and branching characteristics typical of the genus. The author thus follows Bulman (1941, 1955) in recognizing the genus *Adelograptus* as distinct from the genus *Bryograptus* based primarily on the number of primary stripes.

Adelograptus clarki (T. S. Hall 1899)

(Plate 44, fig. 2, 4)

1899a *Bryograptus clarki* T. S. Hall, p. 165-166, Pl. 17, fig. 3, 4.
1932 *Bryograptus victoriae* T. S. Hall-Harris & Keble, Pl. 4, fig. 2.
1938 *Bryograptus clarki* T. S. Hall-Harris & Thomas, Pl. 1, fig. 8.
1941 *Adelograptus victoriae* (T. S. Hall)-Bulman, p. 115.
1960 *Adelograptus clarki* (T. S. Hall)-Thomas, p. 8.
1960 *Bryograptus clarki* T. S. Hall-Thomas, Pl. 1, fig. 7.

LECTOTYPE: Hall (1899a) did not designate a holotype from among the specimens he had available for study in his publication. He figured (1899a, Pl. 17, fig. 3, 4) only one specimen, and it has the designation 'type' in Hall's handwriting on the label with it. That specimen is designated the lectotype and is illustrated (Pl. 44, fig. 2). The specimen has NMV No. P14366.

TYPE LOCALITY AND HORIZON: Hall (1899a, p. 165) stated that the type specimens came from 'a small quarry a few hundred yards to the north of the now deserted Mount William railway station' in the Lancefield Beds near Lancefield, Victoria. The horizon is probably within the Middle Lancefieldian, Zone La2 of the Lancefieldian, as discussed by Thomas (1960).

MATERIAL: The lectotype and 3 topotypes.

DESCRIPTION: Two primary stipes diverge from the sicula at a 130° to 155° angle. They are commonly straight for the greater part of their length, but some bend downward in their distal portions, possibly reflecting a certain amount of distortion during compression. The primary stipes are 4 to 8 mm long, and they widen from 0·4 to 0·6 mm at the apertures of the first autothecae to a maximum of 0·7 to 0·8 mm at the level of the second autothecal aperture and they remain that width for the remainder of their extent. One or both of the primary stipes may bifurcate, although apparently they do not in all specimens. The secondary stipes which arise from such bifurcation are commonly short (0·5 to 2·0 mm long) and they are 0·4 to 0·5 mm wide. They commonly enclose an angle of 20° to 30°.

A secondary stipe is given off from each of the two primary stipes at the level of the first thecal aperture on each by lateral branching. These secondary stipes range in length from 2·5 to 4·1 mm but most are 2·8 to 3·5 mm long. They are 0·4 to 0·5 mm wide. They make a 30° to 70° angle with the primary stipes and they are straight. They bifurcate at their distal tips to short (0·5 to 4·2 mm long) tertiary stipes which are 0·35 to 0·45 mm wide and enclose a 65° to 105° angle.

The rhabdosome thus branches both by bifurcation and lateral branching. The primary stipes are gently declined and the laterally-branched secondary stipes and those stipes that arise from them by bifurcation give a pendent aspect to the rhabdosome.

The autothecae number 5 in 5 mm. No bithecae were observed. The autothecae on the primary stipes overlap ⅓ to ⅔ their length. The ventral walls of these thecae are curved, making a 13° to 18° angle with the stipe axis initially and a 45° to 57° angle with the stipe axis at the thecal aperture. The apertures are straight and make a 45° to 55° angle with the ventral walls.

The siculae are 1·2 to 1·4 mm long and 0·4 to 0·5 mm wide at their apertures. The nemas observed fall within a range of 0·5 to 1·0 mm in length.

REMARKS: The lectotype and topotypes have a distinctive rhabdosome form in which the primary stipes are slightly declined and the laterally-branched secondary stipes are pendent. One set of secondary stipes arises by lateral branching whereas the others arise by bifurcation. These features appear to make this a distinct species.

Bulman (1941, p. 115) placed this species in synonymy with *A. victoriae* without discussion. Harris & Keble (1932, Pl. 4, fig. 2) figured a form with rhabdosome shape similar to that described here for *A. clarki* with the identification *A. victoriae*, and Bulman (1941) may have simply followed an implied opinion in synonymizing *A. clarki* with *A. victoriae*. Examination of the lectotypes of both *A. clarki* and *A. victoriae*, as well as of topotypes of each, has led the author to the opinion that the two are distinct species. The secondary branches in *A. victoriae* appear to arise by bifurcation. Lateral branching was not observed in that species. The primary stipes in *A. victoriae* appear to be more markedly declined than those in *A. clarki* and the rhabdosomes of *A. victoriae* have a more pendent form.

Adelograptus pauxillus Benson and Keble is similar to *A. clarki* in rhabdosome form and in possessing secondary stipes that arise both by bifurcation and lateral branching. The primary stipes in *A. pauxillus* appear to be slightly more declined than those in *A. clarki* and the laterally-branched secondary stipes arise at the level of the second to fourth autothecal aperture in *A. pauxillus*, whereas these stipes arise at the level of the first autothecal aperture in *A. clarki*. The two forms may be no more than varietally distinct as suggested by Bulman (1941, p. 115), but further

investigation into the range of variation of each must be pursued to reveal their relationship.

Adelograptus divergens Elles & Wood has primary stipes that are straight and diverge from the sicula at a lesser angle than those in *A. clarki* and secondary stipes that branch laterally from the primary ones. The general rhabdosome form is somewhat similar to that of *A. clarki* and laterally-branched secondary stipes are present, but the two species are dissimilar in that the laterally-branched stipes in *A. divergens* arise irregularly and apparently do not bifurcate whereas these stipes arise regularly at the first autothecal aperture of the primary stipes in *A. clarki* and they do bifurcate.

Benson and Keble (1935) cited *A. clarki* as being present in their collections from Preservation Inlet, New Zealand but they neither figured nor described it. No comparison may thus be made between the Victorian and New Zealand specimens.

Adelograptus victoriae (T. S. Hall 1899)

(Pl. 44, fig. 1)

1899a *Bryograptus victoriae* T. S. Hall, p. 165, Pl. 17, fig. 1, 2.
1899b *Bryograptus victoriae* T. S. Hall, p. 450, Pl. 22, fig. 11, 12.
1938 *Bryograptus victoriae* T. S. Hall-Harris & Thomas, Pl. 1, fig. 7.
1941 *Adelograptus victoriae* (T. S. Hall)-Bulman, p. 115.
1960 *Adelograptus victoriae* (T. S. Hall)-Thomas, p. 8.
1960 *Bryograptus victoriae* T. S. Hall-Thomas, Pl. 1, fig. 6.

LECTOTYPE: Hall (1899a) did not designate a holotype in his publication from among the specimens he had available for study. He (1899a, Pl. 17, fig. 1, 2) figured only one specimen which has the designation 'type' written on the label with it. That specimen is designated the lectotype and is figured on Pl. 44, fig. 1. It has NMV No. P14240.

TYPE LOCALITY AND HORIZON: Hall (1899a, p. 165) stated that the type specimens came 'from a small quarry a few hundred yards to the north of the now deserted Mount William railway station' in the Lancefield Beds near Lancefield, Victoria. The horizon is probably within the Middle Lancefieldian, Zone La2 of the Lancefieldian, as discussed by Thomas (1960).

MATERIAL: The lectotype and 5 topotypes.

DESCRIPTION: Two primary stipes diverge from the sicula initially at an angle of 130° to 135°. They curve downward within 2 mm from the sicula to ultimately enclose an angle of approximately 60°. The primary stipes are 2 to 6 mm long. They are 0·7 to 0·77 mm wide at the first thecal aperture and they widen slightly, to a maximum of 0·9 mm, near the point of bifurcation.

The primary stipes bifurcate, each giving rise to two secondary stipes which are 2 to 4 mm long and 0·45 to 0·65 mm wide. The secondary stipes enclose an angle of 60° to 90°.

The autothecae number 4 to 4½ in 5 mm. They are approximately 7 to 8 times as long as they are wide and they overlap ⅗ to ½ their length. The ventral walls of all but the proximal two thecae of each primary stipe appear to be straight and they are inclined to the stipe axis at a 25° to 35° angle. The apertures are straight and make a 60° to 70° angle with the ventral walls. The ventral walls of the proximal autothecae are markedly curved. No bithecae were observed on the specimens studied.

The siculae observed are 1·7 to 1·7 mm long and 0·65 to 0·7 mm wide at

their apertures. A short nema of approximately 1 mm length extends from the apex of the sicula.

Remarks: The nearly pendent form of the rhabdosome and the regular bifurcation of the primary branches serve to set this species apart from others. The absence of laterally-branched stipes as well as the near-pendent orientation of the primary stipes sets this species apart from *A. clarki*. The near-pendent form, regularity of bifurcation of the primary stipes, and greater angle of theeal inclination make this species distinct from *A. lapworthi* Ruedemann. *A. victoriae* may be distinguished from *A. simplex* Tornquist by the bifurcation of both primary stipes, whereas one of the primary stipes in *A. simplex* does not bifurcate or branch. Both of these species have pendent rhabdosomes.

Benson and Keble (1935) and Berry (1960b) recorded *A. victoriae* from New Zealand and the Marathon Region, Texas respectively but neither figured nor described the specimens so identified. The North American (Texas) specimens are immature forms with similar rhabdosome form as *A. victoriae*. Detailed comparison between the Texas and Victorian specimens is thus not possible.

Order Graptoloidea Lapworth 1875

Suborder Didymograptina Lapworth 1880 (emend.)

Superfamily Dichograptacea Lapworth 1873

Family Dichograptidae Lapworth 1873

Genus **Brachiograptus** Harris & Keble 1932

Brachiograptus etaformis Harris & Keble 1932

(Pl. 44, fig. 3)

1932 *Brachiograptus etaformis* Harris & Keble, p. 41, Pl. 6, fig. 8, 9.
1938 *Brachiograptus etaformis* Harris & Keble-Harris & Thomas, Pl. 2, fig. 73.
1947 *Loganograptus logani* mut. *pertenuis* Ruedemann (pars) p. 287, Pl. 45, fig. 15, 16.

Holotype: NMV P24109; paratype—NMV P24020.

Type Locality and Horizon: Harris & Keble (1932, p. 48) stated that the holotype and paratype came from 'Strathfieldsaye, Bendigo East'. The type specimens were obtained from beds included in the Zone of *Diplograptus decoratus* by Harris (1935). That Zone was designated 'M. O. 3' by Harris & Thomas (1938) and 'D 3', the third Zone in the Darriwilian by Thomas (1960).

Material: The holotype, the paratype, and 4 topotypes.

Description: To Harris & Keble's (1932, p. 41) thorough description of this species a few observations and measurements may be added. The secondary stipes are up to 15 mm long and they are 0·4 to 0·6 mm wide at the theeal apertures. The lateral stipes are 4 to 8 mm long and 0·5 to 0·6 mm wide across the thecal apertures. The first lateral stipe forms an 80° to 90° angle with the secondary stipe. The succeeding lateral stipes make successively lesser angles with the secondary stipe with the most distal lateral stipes forming a 40° to 45° angle with the secondary stipe. The lateral stipes are separated by the distance of the free portions of the theeae that comprise the secondary stipe. This distance is 1·0 to 1·5 mm. The ventral thecal margins make a 15° to 20° angle with the stipe axis, and they are straight to slightly curved.

The sicula is 0·7 to 0·9 mm long and 0·2 to 0·3 mm wide at its aperture. A short nema is present in some specimens. The first-formed theca originates near the middle of the sicula. The second-formed theca arises from the proximal third of the first-formed and crosses the sicula close to its aperture.

Remarks: The eharaeteristie rhabdosome form and unbranched lateral stipes as well as the slender tubular thecal form and low theeal overlap elearly set this speeies apart. The rhabdosome form and lateral branehing eharaeteristies are unique to the genus. It may have developed from a elonograptid.

North Ameriean speeimens assigned to this speeies have been reeorded from the Marathon Region, Texas (Berry 1960b) and from Glenogle quarry, British Columbia and Hot Springs, Arkansas (Ruedemann 1947, Pl. 45, fig. 15, 16). The Arkansas and Texas speeimens are elosely similar to the Vietorian types in all eharaeteristies and would appear to differ so little that they may not be even subspeeifieally distinet. The branehing of the Glenogle speeimen appears somewhat different from that in the Vietorian types and it may be subspeeifieally or even specifieally distinet. Further study of the Glenogle material is needed to establish its relationship with that from Vietoria as well as that from Texas and Arkansas.

Only the paratype of this speeies has been reprodueed here photographieally as most of the features may be readily seen on it. The holotype is so poorly preserved that no details may be observed on it.

Genus **Tetragraptus** Salter 1863

Tetragraptus decipiens T. S. Hall 1899

(Pl. 44, fig. 5, 10, 11)

1899a *Tetragraptus decipiens* T. S. Hall, p. 168-169, Pl. 17, fig. 13-15; Pl. 18, fig. 16-19.
1920 *Tetragraptus decipiens* T. S. Hall-Keble, p. 199-201, Pl. 34, fig. 1a-e.
1938 *Tetragraptus decipiens* T. S. Hall-Harris & Thomas, Pl. 1, fig. 12.
1960 *Tetragraptus decipiens* T. S. Hall-Thomas, Pl. 1, fig. 11.
1960b *Tetragraptus decipiens* T. S. Hall-Berry, p. 54, Pl. 5, fig. 4.

Lectotype: Hall (1899a) figured several speeimens from among those he studied but he did not designate a holotype in his publieation. The speeimen he figured (1899a) on Pl. 17, fig. 14 and 15 is ehosen to be the leetotype. It has NMV No. P14368, and it is marked 'type' in Hall's handwriting.

Type Locality and Horizon: Hall (1899a, p. 165) stated that the type speeimens eame 'from a small quarry a few hundred yards to the north of the now deserted Mount William railway station' in the Laneefield Beds near Laneefield, Vietoria. The horizon is probably within the Middle Laneefieldian, Zone La2 of the Laneefieldian, as diseussed by Thomas (1960).

Material: The leetotype and 6 topotypes.

Discussion: To Keble's (1920) eomprehensive diseussion of this speeies only a few remarks may be added. The two initially-formed theeae of the rhabdosome appear to have made an angle of approximately 90° with eaeh other. Most of the speeimens are flattened in sueh a manner, however, that this angle seems greater than that. The stipes in the types are 4 to 10 mm long and they widen from 0·5 to 0·6 mm initially to a maximum of 1·0 to 1·3 mm at the seeond theeal aperture of eaeh. They maintain that maximum width for the remainder of their extent. The proximal portions of the ventral theeal margins make a 15° to 20° angle with the stipe axis and the distal portions of the ventral margins make a 20° to 35° angle with the stipe axis. Sieula lengths range from 1·9 to 2·4 mm. Sieula width at the aperture is 0·4 to 0·5 mm.

Speeimens of this speeies are eommonly preserved in sueh a manner that theeal details and even maximum stipe width are diffieult to aseertain. The three types illustrated (Pl. 44, fig. 5, 10, 11) are relatively indieative of the kind of preservation and amount of detail eneountered.

REMARKS: Benson & Keble (1935) cited this species in their collections from New Zealand but neither figured nor described it, hence detailed comparison between the Victorian and New Zealand specimens may not be made. The Marathon Region Texas specimens assigned to this species (Berry 1960b, p. 54, Pl. 5, fig. 4) are similar to the Victorian with the exception that the ventral thecal walls are straight throughout their extent in the Texas material. The Texas specimens are immature and thus close comparison with the Victorian material is not possible. The Texas specimens may be at least subspecifically distinct from the Victorian.

Genus **Phyllograptus** J. Hall 1858

Phyllograptus nobilis Harris & Keble 1932

(Pl. 44, fig. 6-9)

1932 *Phyllograptus nobilis* Harris & Keble, p. 41-42, Pl. 6, fig. 3, 4.
1960b *Phyllograptus nobilis* Harris & Keble-Berry, p. 57-58, Pl. 14, fig. 6, 7.

HOLOTYPE: NMV P240121—the paratypes on the same block with the holotype also have NMV No. P24021. The slab with the topotypes studied has NMV No. P24113.

TYPE LOCALITY AND HORIZON: Harris & Keble (1932, p. 42) stated that 'the type specimens are from the D1 (Upper Darriwil) belt of Bendigo East'. Harris (1935, p. 332) indicated that *P. nobilis* is a common species in the Zone of *Diplograptus decoratus*. That zone was designated 'M. O. 3' by Harris & Thomas (1938) and it was considered as the third zone of the Darriwilian (D3) by Thomas (1960). *P. nobilis* was shown by Thomas (1960) to be restricted to the *Diplograptus decoratus* Zone.

MATERIAL: 15 topotypes and 3 specimens from the Gibbo R., NE. Victoria which have been compared closely with the topotypes.

DESCRIPTION: The rhabdosomes are 12 to 17 mm long and 6·3 to 8·5 mm wide at the point of maximum width. The length to width ratio ranges from 2: 1 to 2·3: 1, but most specimens have a 2: 1 length to width ratio. The rhabdosomes widen gradually to their maximum width which is attained in approximately the initial one-third of the length. The rhabdosomes remain parallel-sided for up to one-third of their length, and then they taper distally. The rhabdosome outline is thus ovoid with the length twice the width. The rhabdosome has the quadriserial scandent arrangement of the main stipes typical of phyllograptids.

The thecae number 6 to 7 in the proximal 5 mm and 11 to 12½ in 10 mm in the medial and distal portions of the rhabdosome. Most commonly, the thecae number 12 in 10 mm in the medial and distal parts of the rhabdosome. The thecae in the medial portion of the rhabdosome are 4 to 5 times as long as they are wide. They appear to overlap almost their entire extent with but a small portion of the ventral margin free where it joins the apertural margin. The apertural margin of all thecae is concave and it curves at its lower side to join the ventral margin. A mucro 0·8 to 1·0 mm is formed there. The mucros project out from the body of the rhabdosome and give it a distinctive appearance. The inner one-fourth to one-third of all thecae is oriented at a 45° to 60° angle to the rhabdosome axis. In the medial and proximal parts of the rhabdosome, the thecae turn sharply after one-fourth to one-third of their length to become horizontal or nearly so, or to be broadly arcuate with the distal portions of the thecae depressed below the horizontal. The distal portions of the medial thecae in most rhabdosomes make an 80° to 85° angle with the rhabdosome axis. The medial and distal portions of the distal thecae also curve to some extent but much less so than those of the medial and proximal

thecae. The distal portions of the distal thecae make a 60° to 70° angle with the rhabdosome axis. The proximal portions commonly make a 45° to 50° angle with the rhabdosome axis. The sharp curvature of the medial and proximal thecae from a highly inclined position in their proximal one-third to a near-horizontal position for the remainder of their extent is a characteristic feature of this species.

REMARKS: The original description of this species was quite general and permitted a wide range of phyllograptids to be included in it or at least compared closely with it. Harris & Keble's (1932, p. 41) original description is: 'Stipes united to form the characteristic phyllograptus polypary, with elongate-ovate, broad oval, or obovate outline. Thecae 11 in 10 mm, direction of curvature varied, but with ventral margins, when clearly seen, sigmoidal. In contact for not quite the full length, apertural margins concave, mucronate with distinct denticle'. The key trait to recognition of this species was indicated to be the sigmoidal curvature of the thecal walls. Examination of the typical specimens as well as others from the general vicinity of Bendigo East did not reveal any marked curvature of the thecal walls. The author considers the distinguishing features of the species to be the marked thecal curvature of the medial and proximal thecae and the distinct mucros. The 2: 1 length to width ratio is another characteristic feature of the species.

The description given was drawn from the topotypes. Other specimens in collections from the general vicinity of Bendigo fall within the range in variation described from the topotypes. Harris & Keble (1932, p. 42) indicated that examples of the species had been collected from the Gibbo R. in NE. Victoria. Examination of specimens from that locality revealed that they were considerably larger than the Bendigo specimens although they did have the marked thecal curvature so characteristic of the species, the thecal mucros, and approximately the same length to width ratio. These specimens thus appear to belong to the species but are perhaps subspecifically distinct. They have been identified as *P.* cf. *P. nobilis* in this study and one of them (NMV P24031) is illustrated here (Pl. 45, fig. 2).

The species may be readily distinguished from *P. angustifolius* J. Hall by its length to width ratio and its length. *P. angustifolius* is commonly considerably longer and has a length to width ratio of three or more to one. The thecae are commonly 12 in 10 mm in this species and 9 to 11 in 10 mm in *P. angustifolius.*

The species is similar to *P. densus* Tornquist in thecal form, but *P. densus* has more thecae in 10 mm, particularly in the proximal portion. *P. densus* has a slightly longer and less wide form than *P. nobilis,* and its length to width ratio is 2·5 or more to 1. The thecal apertures in *P. densus* are not so markedly mucronate as they are in *P. nobilis.*

P. nobilis may be distinguished from *P. ilicifolius* J. Hall by its more markedly curved thecae. The proximal portions of the thecae in *P. nobilis* are more highly inclined than in *P. ilicifolius.* Rhabdosomes of *P. ilicifolius* taper more markedly both distally and proximally from the medial portion than they do in *P. nobilis* and the length to width ratio in *P. ilicifolius* is 1·3: 1 to 2: 1 with the ratio commonly less than 2: 1. This ratio is commonly 2: 1 in *P. nobilis* and may be greater than that but not less.

P. nobilis may be distinguished from *P. typus* J. Hall by the marked curvature of its thecal walls, the more markedly mucronate thecal apertures, and the number of thecae in 10 mm which is 11 to 12½ in *P. nobilis* and but 9 to 10 in *P. typus.* Rhabdosomes of *P. typus* are commonly longer in relation to width than they are in *P. nobilis.*

Although a number of phyllograptids appear to be somewhat similar to *P. nobilis*, it is distinct from all of them. The length to width ratio, the mucronate apertures, and the distinctive thecal curvature serve to set it apart from species other than those specifically discussed.

The Marathon Region, Texas specimens of this species described by Berry (1960b) fall within the range in variation discussed here for the Victorian types. The Texas specimens are thus remarkably similar to the Victorian material of this species from Bendigo.

Genus **Didymograptus** McCoy in Sedgwick & McCoy 1851

Didymograptus dependulus Harris & Keble 1932

(Pl. 45, fig. 3)

1932 *Didymograptus dependulus* Harris & Keble, p. 46, Pl. 6, fig. 1, 2.
1935 *Didymograptus dependulus* Harris & Keble-Benson & Keble, p. 281, Pl. 31, fig. 16.

HOLOTYPE: NMV P24022; Paratype—NMV P24023.

TYPE LOCALITY AND HORIZON: Harris & Keble (1932, p. 48) indicated that the holotype came from Geological Survey of Victoria locality 26, Sz at Steiglitz, Victoria and that the paratype came from Quartz Hill, Castlemaine. They (1932, p. 46) stated that the typical horizon was 'Middle Castlemaine (C4)—the bed above that characterized by *D. bifidus*'. The C4 zone of Harris & Keble (1932) was given the designation Ch3 and assigned to the then newly-introduced Chewton Series by Harris & Thomas (1938). They (1938, p. 65) named their Ch3 zone the 'Zone of *Didymograptus balticus*'. This Zone was apparently given the designation 'Ch2' in the tables presented by Thomas (1960).

MATERIAL: The holotype, the designated paratype, and two additional specimens from Quartz Hill.

DESCRIPTION: The stipes in this pendent didymograptid diverge from the sicula initially at a 120° to 130° angle. They curve very slightly downward in the proximal 3 to 4 mm and then turn abruptly downward so that their distal portions enclose an angle of 25° to 35°.

The stipes are 13 to 16 mm long and they widen from 1·2 to 1·3 mm at the apertures of Th 1^1 and 1^2, to a maximum of 1·6 to 1·8 mm which is attained 3·5 to 5 mm from the sicula. The maximum width is maintained for 4 to 6 mm and then the stipes narrow gradually to 0·8 to 1·0 mm at the aperture of the last theca on each.

The thecae number 9 to 10 in 10 mm. They are 2 to 2½ times as long as they are wide and they overlap approximately ½ their length. The ventral thecal walls curve markedly throughout their extent. The proximal portions of the theeae make a 25° to 35° angle with the stipe axis. The distal portions of the distal theeae make a 55° to 60° angle with the stipe axis, and the distal portions of proximal and medial theeae make a 70° to 80° angle with the stipe axis. Theeal apertures are straight and make a 45° to 55° angle with the ventral walls of the proximal and medial theeae and a 60° to 65° angle with the ventral walls of the distal theeae. Thecal apertures of the proximal and medial theeae are distinctly mucronate.

The sicula is 1·5 to 2·0 mm long and 0 6 to 0·8 mm wide at its aperture. A nema which is up to 6 mm in length projects from the sicula apex. Proximal end development could not be seen.

REMARKS: The marked thecal curvature, mucronate thecal apertures, and distal tapering of the stipes are distinctive features of this species of pendent didymograptid. Thecal curvature is somewhat like that in the *D. murchisoni* group, but

this species is not as robust as any member of that group and stipe shape is quite different, tapering markedly distally for a considerable distance in *D. dependulus*.

Benson & Keble (1935) stated that New Zealand specimens of this species were similar to the Victorian except that the thecae in the New Zealand forms number 12 in 10 mm. The thecal curvature in the New Zealand specimens may not be quite so marked as in the Victorian, but this is difficult to ascertain from study of the published figure and comparison of it with the Victorian material. The New Zealand specimens appear to fall within the species *D. dependulus* but they probably comprise a subspecies which is morphologically distinct from one comprised of the Victorian specimens.

Didymograptus hemicyclus Harris 1933

(Pl. 49, fig. 5, 6)

1933 *Didymograptus hemicyclus* Harris, p. 109-110, Pl. 6, fig. 4; Fig. 68.
1938 *Didymograptus hemicyclus* Harris-Harris & Thomas, p. 76, Pl. ii, fig. 21 a-c.

LECTOTYPE: Harris (1933) did not designate a holotype for this species from the specimens he had available for study. The specimen he figured on Pl. 6, fig. 4 has NMV No. P13797 and was apparently considered the type. That specimen is designated the lectotype.

TYPE LOCALITY AND HORIZON: The type was collected by Mr Thomas Smith in Allotment 19, Parish of Campbelltown, Victoria. Harris (1933, p. 110) stated that the species was 'not uncommon in allotments 16 and 17, Campbelltown, in the lower Bendigonian beds'. Harris & Thomas (1938, p. 78) give the locality of their specimens as 'the good bed, rather more than 10 chains west-south-west from north-east corner of allotment 16A, section II, Campbelltown'. The horizon of the locality from which Smith's specimen (the lectotype) came is in the lower Bendigonian, Zone B5, of the older zonal designations and that zone is Bel of the Bendigo Series according to Harris & Thomas (1938). Thomas (1960) also gives this zone the designation Bcl.

MATERIAL: The lectotype and 5 probable topotypes.

DESCRIPTION: The stipes in this reclined didymograptid diverge initially from the sicula at a 105° to 110° angle, but they curve upward rapidly to a reclined position to give the entire rhabdosome a semi-circular shape. The proximal parts of Th 1^1 and Th 1^2 are declined but their distal parts turn to become horizontal. The thecae that originate from Th 1^1 and 1^2 are directed upward and outward, giving the stipe formed of them its curving, reclined form. The stipes are 6 to 8 mm long. They are 0·8 to 1·0 mm wide at the apertures of Th 1^1 and 1^2 and they are 1·2 to 1·4 mm wide at the apertures of Th 2^1 and 2^2. This is the maximum width of the stipes and it is maintained throughout the remainder of their extent. The width indicated includes the denticulate apertural lip.

The thecae number 4 in 3 mm. They overlap ¼ to ⅓ their length. The ventral thecal walls are markedly curved. Their proximal portions make a 25° to 30° angle with the stipe axis and their distal portions make a 70° to 80° angle with the stipe axis. The apertural margins are straight and normal to the stipe axis. The ventral walls curve markedly in their most distal portions where they join the apertures, giving a sharply denticulate appearance to the apertural lip. The apertural lip is 0·4 to 0·5 mm long.

The sicula is 1·4 to 1·6 mm long and 0·5 mm wide at its aperture. It has a virgella that is 0·3 to 0·5 mm long. Proximal end development is clearly dichograptid. The proximal portion of Th 1^1 makes a 50° to 55° angle with the sicula

and its distal part turns to become horizontal. Th 1^2 originates from the proximal part of Th 1^1 and its proximal part crosses in front of the sicula, making an angle of approximately 50° to 60° with it. Its distal part turns to become horizontal. Th 2^1 originates from the distal part of Th 1^1 and Th 2^2 originates from the distal part of Th 1^2, thus giving the proximal end a developmental pattern much like that sketched by Bulman (1955, p. V56) as the bifidus stage of dichograptid development.

Remarks: The broadly semicircular rhabdosome form and reclined stipes as well as the markedly curved and sharply denticulate thecae make this a distinctive species. The proximal end development is clearly dichograptid and similar to that of other didymograptids.

Didymograptus mundus T. S. Hall 1914

(Pl. 46, fig. 2)

1914 *Didymograptus mundus* T. S. Hall, p. 107, Pl. 17, fig. 9.

Holotype: NMV P14270.

Type Locality and Horizon: Hall (1914, p. 117) cited only 'Bendigo' as the type locality. He (1914, p. 107) stated that the species was 'characteristic of the Upper Bendigonian, and Lower and Middle zones of the Castlemainian'. An entry in the locality register of the National Museum by R. A. Keble cites Diamond Hill, Bendigo, as the type locality.

Material: The holotype and 3 additional specimens from East Bendigo which may have come from a horizon equivalent to that of the holotype.

Description: The stipes in this essentially horizontal didymograptid enclose a 90° to 100° angle as they diverge from the sicula. They turn outward in the distance of approximately 1 mm to enclose a 110° to 120° angle. They maintain this orientation for 3 to 5 mm and then they turn sharply upward to become horizontal or nearly so, with an orientation of 170° to 180° to one another. The marked flexure of the stipes gives the rhabdosome a distinctive, open, inverted V-shape in its proximal region.

The stipes are 18 to 22 mm long. They are 0·8 to 1·0 mm wide at Th 1^1 and Th 1^2, and they widen to a maximum of 1·4 mm in 4 to 5 mm from the sicula. The maximum width is maintained throughout the remainder of their extent.

The thecae number 5¼ to 5½ in the proximal 5 mm and 10 in 10 mm throughout the remainder of the rhabdosome. The thecae at a distance greater than 5 mm from the sicula are about 4 times as long as they are wide at their apertures, and they overlap about ⅓ their length. The proximal thecae have a somewhat greater overlap—about one-half their extent. The ventral thecal walls are curved. Their proximal portions make a 10° to 20° angle with the stipe axis and their distal parts make a 50° to 65° angle with the stipe axis. The apertural margins are straight and make a 60° to 75° angle with the ventral walls.

The sicula is 1·8 to 2·0 mm long and 0·5 mm wide at its aperture. It commonly has a short nema projecting from its apex. Proximal end development is not clear. It may be similar to that of the extensus stage as diagrammed by Bulman (1955, p. V56).

Remarks: The marked flexure of the stipes, the thecal curvature, and the relatively shallow and open inverted V-shape in the proximal region characterize this species. It may be readily distinguished from *D. balticus* Tullberg by its smaller sicula (the sicula in *D. balticus* is 2·5 to 5 mm long), thecal curvature, more nearly

horizontal position of the distal portions of its stipes, and more shallow and open character of the inverted V-shape of the proximal region of its rhabdosome. The marked stipe flexure and thecal curvature set this species apart from *D. simulans* Elles & Wood, and the thecal curvature and more shallow, open character of the inverted V-shape of the proximal region of the rhabdosome in contrast with the more closed inverted V-shape of the same part of the rhabdosome in *D. uniformis* Elles & Wood make it distinct from that species. The sicula in *D. mundus* is smaller, its stipe flexure more marked, and its thecae are curved in comparison with *D. protobalticus* Monsen, and *D. balticus* var. *vicinatus* Monsen. Stipe width, thecal number, and thecal curvature serve to set *D. mundus* apart from other species with which it might be compared.

Benson & Keble (1935, Pl. 31, fig. 22) figured a small fragment that they assigned to *D. mundus*. No description was given and the fragment is both so small and so poorly preserved that its identity as *D. mundus* and its relationship with the Victorian specimens of this species cannot be ascertained.

Didymograptus pritchardi T. S. Hall 1899

(Pl. 45, fig. 1; Pl. 46, fig. 1; Pl. 47, fig. 1, 2)

1899a *Didymograptus pritchardi* T. S. Hall, p. 167, Pl. 17, fig. 7, 9; Pl. 19, fig. 8, 10.
1938 *Didymograptus pritchardi* T. S. Hall-Harris & Thomas, Pl. 1, fig. 13.
1960 *Didymograptus pritchardi* T. S. Hall-Thomas, Pl. 1, fig. 14.

LECTOTYPE: Hall (1899a) did not designate a holotype in his publication from among the specimens he had available for study. The designation 'type' is indicated on the label with the specimen he figured (1899a) on Pl. 17, fig. 7. That specimen is chosen as the lectotype. It has NMV No. P14238. The paratype has NMV No. P14239.

TYPE LOCALITY AND HORIZON: Hall (1899a, p. 165) stated that the type specimens came 'from a small quarry a few hundred yards to the north of the now deserted Mount William railway station' in the Lancefield Beds near Lancefield, Victoria. The horizon is probably within the Middle Lancefieldian, Zone La2 of the Lancefieldian, as discussed by Thomas (1960).

MATERIAL: The lectotype, the paratype, and 5 topotypes.

DESCRIPTION: The stipes in this essentially declined didymograptid diverge from the sicula initially at a 135° to 145° angle. They curve downward throughout their entire length so that their distal portions ultimately enclose a 75° to 85° angle. The stipes have, considered in their entirety, a gently arcuate appearance.

All stipes observed were incomplete. The longest seen measured 12 cm. They are 0·7 to 0·8 mm wide at the apertures of Th 1^1 and 1^2 and they attain their maximum width of 0·8 to 0·9 mm at the apertures of Th 2^1 and 2^2. Maximum stipe width is maintained throughout the remainder of the stipe.

The thecae number 9 to 9½ in 10 mm throughout the rhabdosome. They overlap ⅔ to ½ their length. Their ventral margins are markedly curved. The proximal portions of the ventral thecal margins make a 10° to 12° angle with the stipe axis and the distal portions form a 50° to 65° angle with it. The marked curvature of the ventral thecal margins gives a distinctive appearance to the thecae. The apertural margins are straight and normal or within 10° of normal to the stipe axis. A distinct apertural lip, which gives a marked denticulate appearance to the thecal outline, is formed by the sharply curved distal portion of each ventral wall where it joins the apertural margin.

The sicula is 1·4 to 1·5 mm long and 0·25 to 0·3 mm wide at its aperture. Th 1^1 appears to have originated about in the middle of the sicula and to have grown downward beside it for a short distance before turning outward. The apertural portion of the sicula apparently turned outward toward the stipe originated by Th 1^2. Th 1^2 arose from the proximal portion of the Th 1^1 and erossed the sicula. Th 2^1 originated from the distal part of Th 1^1, and Th 2^2 originated from the distal part of Th 1^2.

Remarks: The long, slender, gently areuate stipes and the markedly eurved, denticulate theeae eharaeterize this species and elearly set it apart from others. Although Spjeldnaes (1963) suggested that *D. pritchardi* might be suspeeted to have bithecae and so belong to the Genus *Kiaerograptus*, no bithecae were observed in either the distal or proximal portions of the stipes of this speeies. The stipes, however, are highly carbonized and the distal portions are eommonly badly distorted by compression, thus bithecae could be present and not be preserved well enough to aseertain their presenee. Although the sicula in *D. pritchardi* appears to flex outward as described by Spjeldnaes in *Kiaerograptus kiaeri*, the proximal end development in *D. pritchardi* differs from that in *K. kiaeri* in most other aspects. The proximal end development in *D. pritchardi* appears to be similar to that in other didymograptids.

One specimen with three stipes instead of two (NMV P14239) but otherwise identical in all charaeteristies to *D. pritchardi* was figured by Hall (1899a, Pl. 17, fig. 9; Pl. 19, fig. 8). Hall (1899a, p. 167) also mentioned having observed similar specimens with four stipes. The four-stiped forms were not seen by the author in the collections examined.

Benson & Keble (1935, p. 285) noted the presence of *D. pritchardi* in their collections from southern New Zealand. They gave neither a figure nor a deseription of the specimens so identified, henee no comparison of them with the Victorian types may be made.

Didymograptus v-deflexus Harris 1924

(Pl. 48, fig. 1)

1916 *Didymograptus v-deflexus* Harris (nomen nudum), p. 55, 60, 63, 64, 66, 70.
1924 *Didymograptus v-deflexus* Harris, p. 93-94, Pl. 7, fig. 1, 2.
1938 *Didymograptus v-deflexus* Harris-Harris & Thomas, Pl. 2, fig. 47.
1960 *Didymograptus v-deflexus* Harris-Thomas, Pl. 5, fig. 51.
1960b *Didymograptus v-deflexus* Harris-Berry, p. 65, Pl. 11, fig. 9.

Holotype: NMV P29; the paratype and some topotypes are on the same slab as the holotype and also have NMV No. P29.

Type Locality and Horizon: Harris (1924, p. 94) stated that the types 'were collected by the Geologieal Survey of Victoria, at Ba 91, Guildford'. Harris (1924, p. 105) also stated that the holotype and paratype came from 'east of Guildford-Daylesford Road, Ba 91, Allot. 9, seet. 7. Q. S. 15 SE.'. The species was indieated by Harris (1924) to be common in beds then included in the Darriwil series. That portion of the old Darriwil series from which the types were obtained was placed in the Yapeen series by Harris & Thomas (1938).

Material: The holotype, the paratype, and 4 topotypes.

Description: To Harris's (1924, p. 93-94) description some additional measurements and observations may be of note. The stipes in this deflexed didymograptid diverge from the sicula initially at a 115° to 130° angle. They turn downward in a distance of 1·0 to 1·5 mm to enclose a 75° to 90° angle. This orientation

of the stipes is maintained for 3·7 to 5·0 mm and then they turn upward through 140° to 145° to enclose a 150° to 160° angle. The stipe curvature gives the rhabdosome a shallow, open, inverted V-shape in its proximal region.

The stipes are 0·7 to 0·75 mm wide at the apertures of Th 1^1 and 1^2 and they widen to a maximum of 1·1 to 1·3 mm in 3·5 to 4·5 mm from the sicula. The maximum width is maintained through the remainder of their extent. A few specimens, those appearing to have been more highly compressed than the others, have a maximum stipe width of 1·5 mm. The stipes commonly are 15 to 25 mm long, but those in some specimens are up to 40 mm long.

The thecae number 5 to 6 in the proximal 5 mm and 8 to 9 in 10 mm in distal parts of the stipes. The thecae are about three to four times as long as they are wide and they overlap about one-half their extent. The ventral thecal margins of those thecae in the proximal 5 mm of the stipes are curved. Their proximal portions make a 15° to 25° angle with the stipe axis, and their distal portions make a 40° to 45° angle with the stipe axis. The ventral thecal margins in thecae more than 5 mm from the sicula are straight and make a 30° to 35° angle with the stipe axis. The apertural margins of all thecae are slightly concave.

REMARKS: The deflexed form of the rhabdosome and the relatively shallow and open character of the inverted V-shape of the proximal region set this species apart from many others. The species is closest to *D. deflexus* Elles & Wood in rhabdosome form and thecal characteristics. The two differ in that *D. deflexus* has 11 to 12 thecae in distal portions of the stipe and 7 in the proximal 5 mm whereas *D. v-deflexus* has 8 to 9 in the distal portions of the stipes and 5 to 6 in the proximal 5 mm. Thecal inclination in *D. deflexus* is 25° to 30°, whereas it is 30° to 35° in *D. v-deflexus*. Maximum stipe width in *D. deflexus* is 1·0 to 1·1 mm, whereas it is somewhat wider in *D. v-deflexus*. The inverted V-shape in the proximal region of *D. v-deflexus* is more open than in *D. deflexus*.

D. v-deflexus may be readily distinguished from *D. v-fractus* Salter because that species has a more closed and deeper inverted V-shape in the proximal region of the rhabdosome and the stipes attain a maximum width of 2·2 to 2·5 mm. Rhabdosome form, as Harris (1924, p. 94) pointed out, serves to distinguish *D. v-deflexus* from *D. uniformis* Elles & Wood and species with rhabdosomes of similar shape because rhabdosomes of such species are essentially horizontal forms.

Corymbograptus v-fragosus Obut & Sobolevskaya is similar to *D. v-deflexus* in rhabdosome form. The stipes are thicker in *C. v-fragosus* than in *D. v-deflexus* and the thecae in *C. v-fragosus* are inclined at a slightly greater angle and are slightly more closely spaced than in *D. v-deflexus*.

Nearly all characters of the Marathon Region, Texas specimens of *D. v-deflexus* (Berry 1960b) fall within their range in variation in the Victorian types of the species. The differences between the Victorian types and the Texas specimens are remarkably slight.

Suborder GLOSSOGRAPTINA Jaanusson 1960

? Family GLOSSOGRAPTIDAE Lapworth 1873 (emend.)

Genus **Paraglossograptus** Mu *in* Hsu 1959

TYPE SPECIES: Although Hsu (1959) described three species of the newly recognized genus *Paraglossograptus*, he did not indicate a type species for this genus nor did he state that Mu had selected one in his consideration of it which had not been published. The author therefore designates *Paraglossograptus latus* Hsu (1959, p. 189, Pl. 5, fig. 5-6) as the type species of the genus.

DISCUSSION: The rhabdosomes in this genus are biserial seandent forms with a virgula. The periderm is slightly attenuated. The theeae are essentially orthograptid with a high degree of overlap and spinose apertures. The apertural margins are thiekened and supported by a list in the speeimens studied. Some or all of the apertural spines bifureate to an upwardly and a downwardly direeted part. These parts are parallel with the ventral margin of the rhabdosome and they join with one another to form a laeinia on the sides of the rhabdosome. Sceondary spines may project from the vertical portions of the laeinia, commonly at the position of a join between an upwardly direeted spine portion from one theea and the downwardly direeted part of another theea. The seeondary spines are oriented at a high angle to the primary spine portions from whieh they originate. Proximal end development of the rhabdosomes in the specimens studied is similar to that diagrammed by Bulman (1955, p. V63, fig. 44) for *Cryptograptus tricornis*. Whether the stipe arrangement is monopleural or dipleural is not obvious from the speeimens available for study. Mu (1963, p. 355) indieated that typical members of this genus had monopleural stipe arrangement. The Australian specimens studied are very similar to the typieal members of the genus whieh have been found in China, therefore they are grouped with them in it.

The speeimens studied and referred to the genus *Paraglossograptus* are similar in many eharacteristics to members of the genus *Glossograptus*. They differ from the members of that genus in possessing a laeinia, a strengthening list along the theeal apertures, and, to some extent, in slight attenuation of the periderm. They do not have the long theeal marginal spines that typify members of the genus *Glossograptus*. They may or may not have monopleural stipe arrangement as members of the genus *Glossograptus* do have.

The rhabdosome form, thecal charaeteristies, thecal apertural spinosity, and at least some proximal end features seem to ally the specimens studied with the genus *Glossograptus* in the Family Glossograptidae. Because they have the differenees outlined, however, they are plaeed in a separate genus whieh appars to have been derived from *Glossograptus*, as noted by Mu (1963, p. 364), by the downbending and bifurcation of some theeal spines and the loss of others as well as the addition of a list along the apertural margin. The stipe arrangement remains open to question in the speeimens studied. If they do have monopleural stipe arrangement, then their relationship to *Glossograptus* is more clear and their inelusion with it in the Family Glossograptidae justified. If, on the other hand, it is dipleural, they would belong to another Family, possibly the Lasiograptidae.

At present, the Australian speeimens appear to eomprise a distinet phyletic group whieh probably developed from a member of the genus *Glossograptus*. Beeause they are so similar to the Chinese specimens grouped in the genus *Paraglossograptus*, they are placed with them in that genus, and that genus is thus eonsidered a phyletically distinct one, a clade.

Paraglossograptus etheridgei (Harris 1924)

(Pl. 48, fig. 3, 5, 6)

1924 *Lasiograptus* (*Thysanograptus*) *etheridgei* Harris, p. 98-99, Pl. 7, fig. 3-7.
1935 *Lasiograptus* (*Thysanograptus*) *etheridgei* Harris-Harris & Thomas, p. 306, fig. 2, no. 28, 29.
1938 *Lasiograptus* (*Thysanograptus*) *etheridgei* Harris-Harris & Thomas, Pl. 2, fig. 58.
1960 *Thysanograptus etheridgei* Harris-Thomas, Pl. 6, fig. 86.
1960b *Hallograptus etheridgei* (Harris)-Berry, p. 95, Pl. 12, fig. 6, 9b; Pl. 13, fig. 4.
1962 *Lasiograptus etheridgei* Harris-Skwarko, p. 236, Fig. 5 (14).

HOLOTYPE: NMV P14406; paratypes have NMV No. P14417 and P14421.

TYPE LOCALITY AND HORIZON: Harris (1924, p. 99) recorded the type specimens from 'a small roadside cutting between Secs. 95 and 98, south of Old Racecourse Hill, Woodend'. The horizon cited by him is in the upper part of the Darriwil series. From Harris's (1935) later discussion, the type horizon would appear to fall in the Zone of *Glyptograptus intersitus* which is shown by Thomas (1960) to be the second Zone (D2) of the Darriwil series.

MATERIAL: The holotype, 4 paratypes, and 4 topotypes. The paratype with NMV No. P14417 is from Section 20, Parish of Newham (Geological Survey of Victoria locality Bb 29). In addition to the types, 5 specimens from a small gutter on the SW. side of the 'Strathfieldsaye-Sedgwick road about 11 chains NW. of SW. corner of allot. 1B, sect. V, Parish of Strathfieldsaye' studied by Harris & Thomas (1935, p. 307) and 7 specimens from the butts of the Wellsford Rifle Range in the Parish of Sandhurst collected by the author were examined in this study. They were not used in the description given below as that was drawn from the holotype, paratypes, and topotypes. One of the specimens from the Wellsford Rifle Range is figured (Pl. 48, fig. 6) for comparison with the types. It has NMV No. P24026.

DESCRIPTION: The rhabdosomes are biserial scandent forms in which the periderm appears relatively thin. They are 14 to 27 mm long. Their width, without thecal spines, is 1·3 to 1·5 mm at the level of Th 1^1 and they widen to 2·8 to 3·0 mm at 5 mm from that level to a maximum of 3·9 to 4·1 mm which is attained at a distance of 5½ to 7½ mm from the level of Th 1^1. Some forms remain parallel-sided for the remainder of their extent. Others are parallel-sided for much of their length and taper slightly in their distal 3 to 6 mm to a width of 3·1 to 3·7 mm at their distal extremity. The holotype and one paratype taper distally and other paratypes and topotypes remain parallel-sided throughout. Some variation in rhabdosome form thus exists among the typical specimens which are similar in other characteristics.

The thecae are orthograptid in type and they alternate. They are relatively similar to thecae of the spinose orthograpti included by Elles and Wood (1907, p. 223-233) in Group I. The thecae number 6 to 6½ in the proximal 5 mm, 11 to 12 in the proximal 10 mm, and 9 to 10 in the distal 10 mm. They are 1·7 to 1·9 mm long and they overlap 0·8 to 0·9 mm. The free portions of their ventral walls are straight for the greater part of their extent and are inclined to the rhabdosome axis at 10° or less. Those in the medial part of the rhabdosome appear vertical in most specimens. The free ventral wall near the apertural margin curves markedly to horizontal or within a few degrees of it as it joins the apertural margin. The apertural margins are strengthened by a list which is relatively thick near the ventral margin of the rhabdosome.

All of the thecal apertures are spinose. The spines are variable in size and shape within any one rhabdosome and no consistent pattern of spine arrangement is obvious in any one rhabdosome or from rhabdosome to rhabdosome. Some spines are 3 to 4 mm long, are inclined to the rhabdsosome axis at a high angle, and are straight or slightly curved. They do not appear to bifurcate. Their distal portions may curve downward to such an extent that they fuse with thecal spines of thecae beneath them. These spines have been termed 'normal apertural spines' by Hsu (1959, p. 173, Fig. 3). Other apertural spines are shorter, being 1·0 to 1·3 mm long, and they appear to bifurcate to two vertically-oriented portions one of which is upwardly directed and the other downwardly. The vertical portions extend upward and down-

ward to join a long 'normal apertural spine', a vertical portion from another short spine, or the down-bent portion of an intermediate length spine. The vertical portions of these spines join with each other to form a lacinia on the sides of the main body of the rhabdosome. The lacinia is approximately 1 to 1·5 mm from the ventral margin of the rhabdosome. The long 'normal' apertural spines and the short bifurcating spines are the most common spines on the rhabdosome. Some spines of intermediate length may also be present. Their distal portions commonly curve downward to join a long spine. In addition, some of these intermediate length spines appear to have given rise to two or three downwardly-directed offshoots which join a long spine as do their distal tips. The long and the short-bifurcating are the most commonly observed types of apertural spines. The intermediate type is relatively rare in this species. In most rhabdosomes, all the proximal thecae give rise to either the short-bifurcating or the long type of apertural spine. In the medial, and particularly in the distal, portions of the rhabdosome, however, the two types may alternate or two or three short bifurcating types may occur between each long normal type. The intermediate length apertural spine may or may not appear in any one rhabdosome. If such spines are present, they rarely occur on both sides of the rhabdosome. If they do, they originate from thecae at different levels. The same type of spine may not occur on opposing thecae.

Rarely, a secondary spine may originate from the vertical portion of one of the short bifurcating spines. Secondary spines are slightly curved and 1 to 3 mm long. They appear to originate at or near the join of the upwardly and downwardly directed vertical portions of two short-bifurcating spines.

The sicula structure appears to be 1·3 to 1·5 mm long and 0·7 to 1·0 mm wide at its aperture. It is similar to that diagrammed by Bulman (1955, p. V63, Fig. 44) for *Cryptograptus tricornis* in the presence of lists that appear to outline and support the sicula. The area of the sicula aperture is surounded by a ring-like structure composed of lists from which two downwardly-directed Y-shaped spines and two lateral spines originate. The Y-shaped spines are centrally located and 0·5 to 0·75 mm long. The lateral spines are 0·5 to 0·9 mm long, straight, and make a 20° to 30° angle with the rhabdosome axis. Budding from the sicula is not clear in the specimens studied. Both Th 1^1 and 1^2 appear to have been closely pressed against the sicula for the greater part of their length and to have bent obliquely upward in their apertural portions.

The rhabdosomes have a stout virgula that is 0·2 to 0·35 mm wide and although commonly broken, is at least 2 mm long. A relatively stout median septum may be seen in most rhabdosomes. It begins at the level of the fourth thecal aperture.

Remarks: The forms in which the rhabdosomes taper distally are identical to those with parallel-sided rhabdosomes in all other characteristics, thus the two types of rhabdosome are included in the same species. Also, although some specimens have few or no long normal or intermediate length spines and others have relatively numerous intermediate length spines with varying numbers of offshoots, all other characteristics of the rhabdosomes are the same. The species is thus considered to be somewhat variable in regard to rhabdosome form and apertural spine type and arrangement. The typifying characteristics of this species in comparison with others of the same genus are considered to be the maximum width (3·9 to 4·1 mm), the number of thecae in 10 mm (9 in 10 mm distally and 11 to 12 in 10 mm proximally), and the distinctly *Cryptograptus*-like list structure about the sicula. *P. regularis* Hsu is perhaps most nearly like *P. etheridgei* but differs in being more slender (3 mm) and if a list structure similar to that in *P. etheridgei* is present at the proximal end, the arrangement and size of the lists and spines

appear to differ. *P. typicalis* appears to have more thecae and to be slightly more slender. *P. latus* Hsu has more thecae and does not appear to have a list structure at the proximal end similar to that in *P. etheridgei*. *P. multifibratus* Hsu and its variety are both more slender than *P. etheridgei*.

Some of the specimens from Strathfieldsaye and those from Wellsford are similar to the types with the exception that they are not as wide. Most of these specimens are a maximum width of 3·0 mm, but some are only 2·5 mm wide. The thinnest specimens have 6½ to 7 thecae in their proximal 5 mm and 10 in the distal 10 mm. The specimens with a maximum width of 3 mm are similar to the types in all other characteristics. They might be referred to *P. regularis* Hsu but the proximal features of that species are not clear whereas those in the specimens studied are clearly those described for the typical material of *P. etheridgei*. A more extensive study of all specimens of *P. etheridgei* obtained from all localities is needed to ascertain whether or not the thinner forms are subspecifically or perhaps only infra-subspecifically distinct from those at the Woodend locality. The Marathon Region, Texas specimens are similar to those with maximum width of 3·0 mm from Strathfieldsaye, and the New Zealand specimens referred to *P. etheridgei* by Skwarko (1962, p. 236, Fig. 5 (14)) are similar to the thinnest specimens (those with maximum width of 2·5 mm). For the present, all of these forms are tentatively retained within the species, but they may be subspecies within this species.

The forms referred here to *Paraglossograptus etheridgei* have in the past been referred to both *Lasiograptus* (Harris 1924; and Harris & Thomas 1935) and *Hallograptus* (Berry 1960b). They may readily be distinguished from *Lasiograptus* by their essentially orthograptid thecae because thecae in *Lasiograptus* are amplexograptid. *Hallograptus* has orthograptid thecae that are spinose but it does not have lacinia. *P. etheridgei* has a proximal end structure similar to that in *Cryptograptus tricornis* whereas, as far as is known, both *Lasiograptus* and *Hallograptus* have diplograptid development. Further, both *Lasiograptus* and *Hallograptus* have dipleural stipe arrangement whereas *P. etheridgei* may not. Jaanusson (1960, p. 336) initially suggested that this species 'seems to belong to the genus *Paraglossograptus* (Mu *in* Hsu 1959)'. Jackson (1964, p. 527) followed this suggestion.

Suborder DIPLOGRAPTINA Lapworth 1880 (emend.)

Family DIPLOGRAPTIDAE Lapworth 1873

Genus **Diplograptus** McCoy 1850

Diplograptus ingens T. S. Hall 1906

(Pl. 49, fig. 1, 2, 7)

1906 *Diplograptus ingens* T. S. Hall, p. 276, Pl. 34, fig. 7.
1938 *Diplograptus* (? *Mesograptus*) *ingens* T. S. Hall-Harris & Thomas, Pl. 3, fig. 101.
1955 *Diplograptus* (*Mesograptus*) *ingens* T. S. Hall-Harris & Thomas, p. 37, fig. 30.
1960 *Diplograptus* (sen. st.) *ingens* T. S. Hall-Thomas, Pl. 10, fig. 131.

LECTOTYPE: Hall (1906) did not designate a holotype for this species in publication. He (1906, Pl. 34, fig. 7) figured one specimen which is designated herein the lectotype. The specimen has NMV No. P14272.

TYPE LOCALITY AND HORIZON: Hall (1906, p. 274) stated that the type specimens came 'from three-quarters of a mile north-west of Mount Easton'. The locality was given the designation F 23. The horizon from which the types came is within the Eastonian and is probably from the upper part of it, the Zone of *Dicranograptus hians*.

MATERIAL: The lectotype and 15 topotypes.

DESCRIPTION: These biserial scandent rhabdosomes are 30 to 60 mm long. They widen from 0·4 to 0·7 mm at Th 1^1 to 2·0 to 2·4 mm at 5 mm from Th 1^1, to 4·2 to 5·0 mm at 10 mm from Th 1^1, to a maximum of 7·0 to 7·4 mm which is attained 15 to 20 mm from Th 1^1. The rhabdosomes maintain their maximum width for most of the remainder of their length, but they taper slightly in the distal 10 mm to a width of 6·0 to 6·5 mm at their distal extremities. The rhabdosomes are thus distinguished by marked tapering in the proximal 10 mm to a very slender origin. The gradual rhabdosome widening in the initial 10 mm then rapid widening in the next 5 to 10 mm and the slight distal tapering make the rhabdosome shape of this species distinctive.

The thecae number 6 in the proximal 5 mm and 11 to 12 in the proximal 10 mm. They number 9 to 10 in 10 mm in medial and distal portions of the rhabdosome.

The proximal 6 to 11 thecae on each side of the rhabdosome are essentially climacograptid in shape. Their genicular angles are 90°, and the supragenicular portions of the free ventral walls of these thecae are straight, vertical in the most proximal thecae and inclined to the rhabdosome axis at an angle less than 12° in the more distal ones, and 0·6 to 0·75 mm long. The apertural excavations of these thecae are 0·1 to 0·2 mm deep and 0·15 to 0·25 mm high at the ventral margins of the rhabdosome.

The thecae distal from the climacograptid ones are essentially glyptograptid in form but with very gently curving ventral walls. They are inclined to the rhabdosome axis at a 30° to 45° angle and most are inclined at a 35° to 40° angle. Those thecae more distal than 15 mm from Th 1^1 are 5·5 to 6·0 mm long, 0·7 to 0·8 mm wide, and overlap ⅓ to ⅝ their length. The apertural margins are straight to slightly concave and they make a 50° to 70° angle with the ventral wall.

The sicula was not observed. A short virgula up to 1 mm in length extends from the sicula aperture.

A short, slender virgula is present. A median septum is also present. It appears to originate at the level of the first glyptograptid theca and to continue throughout the remainder of the theecate part of the rhabdosome.

REMARKS: The distinctive proximal end and rate of widening set this species apart from other diplograptids. The rhabdosomes of this species are wider than those of most other diplograptids. Harris & Thomas (1955) recognized a variety of this species (var. *wellingtonensis*) which is thinner and has more thecae in 10 mm than the typical forms. The variety occurs with the typical forms at Mt Easton and it is also present in collections from the Wellington R. area.

Genus **Orthograptus** Lapworth 1873

Orthograptus truncatus var. **abbreviatus** (Elles & Wood 1907)

(Pl. 48, fig. 2, 4)

1902 *Diplograptus carnei* T. S. Hall (pars ?), p. 53, Pl. 12, fig. 6.
1907 *Diplograptus* (*Orthograptus*) *truncatus* var. *abbreviatus* Elles & Wood, p. 235-236, Fig. 155 a-d; Pl. 29, fig. 6 a-e.

LOCALITY: The specimens came from Stockyard Ck, Wellesley County, New South Wales. The horizon there is within the Zone of *Dicellograptus* cf. *D. complanatus* which is the youngest of the Australian Ordovician and the younger of the two zones of the Bolindian.

MATERIAL: 8 specimens in the collections of the National Museum of Victoria were examined closely. These had been identified as *Diplograptus carnei* and were topotypes of that species described by Hall (1902).

DESCRIPTION: The rhabdosomes are 15 to 23 mm long. They widen from 0·6 to 0·8 mm at the aperture of Th 1^1 to 1·8 to 2·1 mm at 5 mm from that level, to 2·3 to 2·6 mm at 10 mm from that level, and to 2·8 to 3·1 mm at 15 mm from that level. They remain the maximum width, after attaining it, for the remainder of their length.

The thecae number 6½ to 7 in the initial 5 mm, 13 in the initial 10 mm, and 13 in 10 mm distally. They are 1·8 to 2·0 mm long, 0·5 to 0·65 mm wide at their apertures, and overlap 1·0 to 1·2 mm. They widen slightly towards their apertures. They are inclined at a 35° to 50° angle to the rhabdosome axis. The thecal walls are essentially straight and the thecae have a sort of tubular form in which the apertural end is wider than the inner portion. The apertural margins are straight and normal to the ventral walls.

The sicula has a short virgella. Both Th 1^1 and 1^2 have short mesial spines that are up to 0·5 mm long.

REMARKS: Examination of a few of Hall's (1902) topotypes of *Diplograptus carnei* in the collections of the National Museum of Victoria has shown them to be orthograptids of the *O. truncatus* group and to fall within the range in variation of British specimens of that group designated *O. truncatus* var. *abbreviatus* by Elles & Wood (1907). Keble & Benson (1939, p. 81), Ruedemann (1947, p. 403), and Harris & Thomas (1955, p. 35) all expressed the opinion that *D. carnei* should be considered a member of the *O. truncatus* group. Their opinion is supported by this examination of a few of Hall's (1902) topotypes of *D. carnei*.

The specimens examined have a maximum width of 3·1 mm whereas Hall (1902, p. 53) indicated a maximum width of 3·5 mm for *D. carnei*. He also noted 10 to 11 thecae in 10 mm for *D. carnei* and the specimens examined have 13 in 10 mm. The specimens studied are remarkably similar to those of *O. truncatus* var. *abbreviatus* figured by Elles & Wood (1907, Pl. 20, fig. b a-e). Thecae in the British specimens commonly number 10 or 11 in 10 mm in distal portions of the rhabdosome but they do number as many as 12 or 13 in 10 mm in this part of the rhabdosome in some specimens. Aside from the fact that the number of thecae in 10 mm is commonly slightly greater in the Australian specimens than in the British, they are very similar in all features and thus if further study of all specimens of Hall's (1902) *D. carnei* reveal them to be as similar to *O. truncatus* var. *abbreviatus* as the specimens examined are, then *D. carnei* and *O. truncatus* var. *abbreviatus* are synonyms.

Genus **Climacograptus** J. Hall 1865

Climacograptus bicornis subspecies **longispina** T. S. Hall 1902

(Pl. 49, fig. 3, 4)

1902 *Climacograptus bicornis* var. *longispina* T. S. Hall, p. 54, Pl. 12, fig. 8, 9.
1963 *Climacograptus bicornis* var. *longispina* T. S. Hall-Ross & Berry, p. 118, Pl. 8, fig. 13.

LECTOTYPE: Hall (1902) did not designate a holotype in his publication from among the specimens he had available for study. The author designates the specimen figured by Hall (1902) on Pl. 12, fig. 8 as the lectotype. It has the number F46106 in the collections of The Australian Museum, Sydney.

TYPE LOCALITY AND HORIZON: Stockyard Ck, Wellesley County, New South Wales. The typical specimens are from the Zone of *Dicellograptus* cf. *D. com-*

planatus which is the youngest graptolite zone in the Australian Ordovician and the younger of the two zones in the Bolindian.

MATERIAL: The lectotype and 18 topotypes.

DESCRIPTION: The rhabdosomes are up to 40 mm in length. They widen from 0·8 to 0·95 mm at the aperture of Th 1^1 to 1·4 to 1·65 mm at 5 mm from that level, to 2·0 to 2·1 mm at 10 mm from that level, to 2·0 to 2·3 mm at 15 mm from that level. The maximum width attained by most specimens is 2·0 mm, and it is commonly attained 9 to 11 mm from the level of Th 1^1. A few specimens continue to widen to a maximum width of as much as 2·3 mm at 15 to 17 mm from the level of Th 1^1. The rhabdosomes are parallel-sided for the remainder of their extent after attainment of maximum width.

The thecae number 6 in the proximal 5 mm, 11 in the proximal 10 mm, and 9½ to 10 in 10 mm in distal portions of the rhabdosome. The genicular angle is 90° and the supragenicular portions of the free ventral walls are parallel to the rhabdosome axis. The supragenicular portions of the ventral walls in those thecae more than 10 mm from the level of Th 1^1 are 0·85 to 0·9 mm long. The apertural margins are straight and normal to the rhabdosome axis. The apertural excavations are relatively narrow, deep slits. They are 0·15 to 0·2 mm high and 0·45 to 0·55 mm deep.

The sicula was not observed. The proximal end has two distinctive spines which curve outward and downward from the level of the sicula aperture. The spines are 5 to 10 mm long and 0·5 to 0·6 mm wide at their origin. Each diverges from the level of the sicula aperture and makes an initial angle of 65° to 70° with the rhabdosome axis. The spines then curve outward and downward so that their distal portions are parallel to each other and oriented vertically. The outward curvature of the spines and their ultimate orientation to each other are characteristic features of this form.

REMARKS: The spine orientation and curvature clearly set this form apart from typical members of *C. bicornis*. Closely similar forms have been found in the Basin Ranges in the western United States (Ross & Berry 1963).

Specimens from the Basin Ranges described by Ross & Berry (1963, p. 118, Pl. 8, fig. 13) as *C. bicornis* var. *longispina* are slightly wider than the Australian specimens for they widen to a maximum of 2·5 mm and the thecal number is slightly different, being 8 to 10 in 10 mm in the American specimens and 9½ or 10 to 11 in 10 mm in the Australian specimens. The American specimens widen at the same rate as the Australian and the characteristic spines are similar in shape and orientation. The spines in the American specimens are commonly slightly longer than they are in the Australian, although they are identical in dimensions in a few specimens from both places. The American specimens are so similar that they may best be considered to represent a local population of this form with its distinctive rhabdosome shape and spine curvature. The degree of difference between the American and Australian forms appears to be of the magnitude of but a local, and to some extent geographically isolated, population in a much larger more inclusive population. The American and Australian forms were probably in existence at the same time, as nearly as may be reckoned from correlations based upon species associated with each.

The specimens designated *C. hvalross* by Ross & Berry (1963, p. 124-125, Pl. 8, fig. 19, 26, 27) are also similar to *C. bicornis* subsp. *longispina*. The rhabdosomes in *C. hvalross* widen at the same rate as those in *C. bicornis* subsp. *longispina*. Those of *C. hvalross* attain a maximum width of 2·0 mm in 9 mm

from the proximal end and they are parallel-sided thereafter. The majority of the topotypes of *C. bicornis* subsp. *longispina* similarly attain a maximum width of 2·0 mm in 9 to 10 mm from the proximal end, and they are parallel-sided for the remainder of their extent. The thecae in *C. hvalross* number 14 in the initial 10 mm and 12½ in 10 mm in distal portions of the rhabdosome whereas the thecae number 11 in the proximal 10 mm and 9½ to 10 in the distal portions of the rhabdosome in *C. bicornis* subsp. *longispina*. The free ventral portions of the thecal walls in *C. hvalross* appear to be slightly inclined to the rhabdosome axis and the genicular angle is not sharply angular but somewhat rounded. The spines in *C. hvalross* have the same curvature as those in *C. bicornis* subsp. *longispina*. The spines of the two forms differ in that those in *C. hvalross* are thickened by a membranous covering for approximately one-half their length whereas those in *C. bicornis* subsp. *longispina* are not. Without membranous covering, the spines in *C. hvalross* would be slightly thinner than those in *C. bicornis* subsp. *longispina*.

The differences in thecal characteristics may be sufficient to separate *C. hvalross* as a species distinct from members of the *C. bicornis* group. If so, then convergence may be noted in the characteristic curvature of the spines seen in both *C. hvalross* and *C. bicornis* subsp. *longispina*. The membranous covering about the spines in *C. hvalross* is a feature not seen in *C. bicornis* subsp. *longispina* and may also be used to distinguish the two. Unfortunately, preservation of the specimens of both *C. hvalross* and *C. bicornis* subsp. *longispina* is such that precise comparison of thecal detail is not possible, and the possibility exists that the two may not belong to separate species.

Climacograptus riddellensis Harris 1924

(Pl. 50, fig. 1-5)

1924 *Climacograptus riddellensis* Harris, p. 100-101, Pl. 8, fig. 11, 12.
1960b *Climacograptus riddellensis* Harris-Berry, p. 82, Pl. 14, fig. 9, 10.

Type Locality and Horizon: Geological Survey of Victoria locality Ba 67 which is at the junction of Riddell's and Jackson's Creeks, 6½ miles N. 86°E. from the centre of Gisborne, Victoria. The beds at that locality are in the Zone of *Glyptograptus teretiusculus*, the youngest of the Darriwilian zones.

Material: 55 topotypes.

Description: The rhabdosomes are 30 to 40 mm long. They are 0·6 to 0·9 mm wide at the aperture of Th 1[1] and they widen to 1·2 to 1·5 mm at 5 mm from that level to their maximum width within 8 to 10 mm from that level. The maximum width attained in uncrushed specimens preserved in full view is 1·7 to 2·0 mm. Many specimens appear to be somewhat crushed in from the sides or are preserved in a sub-scalariform view. Maximum width of these specimens is commonly 1·4 to 1·5 mm. The maximum width is maintained for much of the extent of the medial part of the rhabdosome. The rhabdosomes taper in the distal 8 to 10 mm to a width of 1·2 to 1·5 mm at their distal extremity. The rhabdosomes thus have an elongate fusiform shape in which the medial portion is parallel-sided.

The thecae number 6½ to 7 in the proximal 5 mm, 12 to 13 in the proximal 10 mm, and 10 to 11 in 10 mm in the distal portion of the rhabdosome. The thecae are slightly alternate in position. They have marked sigmoidal curvature. The genicular angle is 90°. The infrageniculum in thecae in the medial portion of the rhabdosome is normal to the rhabdosome axis at the ventral margin and it is strengthened by a list. The suprageniculum portion of the free ventral wall is straight, parallel to the rhabdosome axis, and 0·75 to 0·8 mm long. The apertural excavations

are pouch-shaped. Those of thecae in the medial and distal parts of the rhabdosome are 0·2 to 0·25 mm high at the ventral margin of the rhabdosome and they curve downward into the rhabdosome for a distance of 0·3 to 0·4 mm. They maintain a width of 0·2 to 0·3 mm throughout their extent. The deepest part of the excavation is 0·45 to 0·5 mm in from the ventral wall of the rhabdosome.

The sicula is approximately 1·0 mm long and 0·2 to 0·3 mm wide at its aperture. A thin virgella 0·5 to 2·0 mm long extends down from the sicula aperture. Th 1^1 appears to have arisen from the medial or apertural portion of the sicula and to have grown downward for a very short distance before turning upward. It grew upward for the greater part of its extent. Th 1^2 appears to have arisen from a medial position on Th 1^1, to have grown across the sicula and turned upward. The greatest part of its length is oriented upward. Proximal end development appears to have been essentially prosoblastic in type. No features were seen that would suggest the streptoblastic type of development.

A median septum is present that arises at the level of the aperture of Th 2^1. The median septum is straight throughout its extent. A thin virgula extends above the thecate part of the rhabdosome.

Remarks: The fusiform rhabdosome shape and pouch-shaped apertural excavations characterize this species. Unlike other climacograptids with similar apertural excavations, this species has a straight median septum, straight supragenicular portions of the ventral thecal walls, and apparently prosoblastic type development. The only feature in which this species resembles members of the Genus *Pseudoclimacograptus*, to which genus it was assigned by Jaanusson (1960, p. 325), is the pouch-shape of the apertural excavations. The differences in median septum shape, form of the supragenicular portions of the ventral thecal walls, and proximal end development distinguish it from members of the Genus *Pseudoclimacograptus*. It is retained within the Genus *Climacograptus* at present as it belongs to a phyletic lineage distinct from that including *Pseudoclimacograptus*. Convergence, which may have some adaptive significance in a specific environmental situation, is thus seen in the character of apertural excavation shape as it appears in *C. riddellensis* and in some members of the Genus *Pseudoclimacograptus*.

Many rhabdosomes of this species are preserved in a sub-scalariform view. These specimens are slightly thinner than those preserved in full view and their apertural excavations are elliptical and appear to touch the median septum. The pouch-shape of the excavations may commonly be noted on one side of such specimens.

The specimens figured herein are topotypes collected by the author. They have been included primarily for comparison with specimens of *Pseudoclimacograptus scharenbergi* obtained from the same exposures.

The Marathon Region, Texas specimens of *C. riddellensis* (Berry 1960b, p. 82) are similar in all details to the Victorian specimens and clearly fall within the range in variation in all characters of the Victorian typical specimens. Many of the specimens included in the species by Ross & Berry (1963) from the North American Great Basin also fall within the range in variation of the Victorian typical specimens.

Genus **Pseudoclimacograptus** Přibyl 1947

Type Species: *Climacograptus scharenbergi* Lapworth 1876.

Přibyl (1947, p. 21) described this genus as follows: 'Rhabdosome straight, with zig-zag median septum, which divides the rhabdosome in the middle into two parallel series of thecae. The median septum is connected under an angle on each

side by transverse strengthening rods with the interthecal septum'. He went on to point out that the thecae were markedly curved, that the free portions of the ventral walls had convex curvature, and that the apertural margins were introtorted. Přibyl pointed particularly to the zig-zag form of the median septum and the fact that horizontal rods which projected from the angles of it joined the interthecal septa. He (1947) figured two forms among his figures of *P. scharenbergi*, the genotype of the new genus. One (Pl. 2, fig. 10) is of a specimen in which the horizontal rods do not join the interthecal septa. In all the other forms figured (Pl. 1, fig. 2; Pl. 2, fig. 2, 3, 4, 5, 6), the horizontal rods do join the interthecal septa.

Jaanusson (1960, p. 326) noted that 'the shape of the median septum does not seem to be a sufficiently stable feature to serve as the basis of the definition of a genus'. He noted that some species with thecal characteristics of *Pseudoclimacograptus* had median septa that began with zig-zag form and became undulating and others had an undulatory to straight median septum. Jaanusson (1960, p. 326) went on to state that: 'The feature which in the present writer's opinion characterizes the group of species included here in *Pseudoclimacograptus* is the distinctly convex supragenicular wall of the thecae and deep thecal excavations'.

Typical specimens of Přibyl's genotype for this genus have (cf. Elles & Wood 1906, p. 206-208, Pl. 27, fig. 14 a-e) zig-zag median septa, marked sigmoidal curvature of the thecae, slight convex curvature of the free portions of the ventral thecal walls, moderately wide and deep apertural excavations, and horizontal projections from the angles of the median septa that end freely and do not join the interthecal septa. The typical specimens of the genotype thus do not have one of the features Přibyl (1947) indicated was diagnostic for the genus. Přibyl (1947, Pl. 1, fig. 2; Pl. 2, fig. 2-6) figured specimens he apparently considered typical of the new genus which had originally been figured and described by Bulman (1932, p. 6-10, Fig. 3; Pl. 1, fig. 12, 13, 14, 19, 21) as *Climacograptus scharenbergi*. The horizontal projections from the angles of the median septa in these forms do join the interthecal septa. These particular specimens differ from *P. scharenbergi*, however, not only in this feature but also in the shape of both the apertural excavations and the thecae as indicated by Jaanusson (1960, p. 327-329, Fig. 7A, Pl. 4, fig. 10). Because of the differences, Jaanusson (1960, p. 327-328) considered these specimens to be distinct from *C. scharenbergi* and he placed them in a new species, *P. eurystoma*. Lee (1963, p. 574-575) subsequently named a new genus, *Prolasiograptus*, to include lasiograptids with an undulatory or zig-zag shaped median septum, clathria, and genicular spines. He included Jaanusson's species *P. eurystoma* in this new genus. Those specimens that Přibyl (1947) apparently had most clearly in mind as typical of his genus *Pseudoclimacograptus* have thus not only been removed from the species Přibyl (1947) chose as the type of his new genus, but they have also been placed in an entirely different genus in the course of subsequent study by others.

The specimens that Jaanusson (1960) grouped in *P. eurystoma* are distinct from *P. scharenbergi*. They have a sort of clathria and a distinctive form to their apertural excavations and thecae that is, to some extent at least, as much lasiograptid in character as it is climacograptid. These specimens appear to be transitional forms between certain climacograptids and lasiograptids of the *L. retusus* type in which the thecae are more nearly truly lasiograptid and a clathria is present in which horizontal lists directed outward from the angles of zig-zag shaped median septa join the interthecal septa. The thecae in such lasiograptids are more nearly truly lasiograptid than are those in *P. eurystoma* and the geniculum is commonly

spinose or has a short flange. Lee (1963, p. 574-575) grouped lasiograptids with these features in his genus *Prolasiograptus*. Lasiograptids of this type apparently gave rise to the more typical lasiograptids which have, in addition to clathria and lasiograptid thecae, lacinia and mesial spines. Genicular spines are present on some thecae of such lasiograptids although they are rare in them. The median septum in such lasiograptids is straight.

An evolutionary developmental sequence thus appears to exist in which *P. eurystoma* is a transitional form between certain climacograptids with an undulatory to zig-zag median septum, horizontal projections from the angles of the median septum that end freely and do not join the interthecal septa, and deep apertural excavations and lasiograptids of the *L. retusus* type. The *L. retusus* type lasiograptids apparently gave rise to the more typical lasiograptids such as *L. costatus*. Whether generic names should be applied to each step along this seeming line of evolutionary development from certain climacograptids to lasiograptids is, to some extent at least, a matter of opinion. The true lasiograptids would seem to be so few in number and so variable among themselves that one broadly-defined genus, *Lasiograptus*, could include them. A distinction, if desired, could be made at the sub-generic level. Further, although a genus could be based upon the single species *P. eurystoma* as it appears to be essentially transitional between two genera, it is but a single species with perhaps more affinities with the climacograptids. It is considered here to be a part of the genus *Pseudoclimacograptus*. Included with it in that genus are those climacograptids with these features: a form of streptoblastic proximal end development, a median septum that is undulatory or zig-zag in shape for at least a part of its extent, slightly to markedly convex supragenicular portions of the ventral thecal walls, and relatively deep apertural excavations. The apertural excavations may have the form of deep open to deep narrow slits or they may be pouch-like in shape. The climacograptids with these characteristics appear to form a plexus of species distinct from other climacograptids. If they do, and if *P. eurystoma* be considered the basis for a genus distinct from them, then a new generic name is needed for them because Přibyl's (1947) apparent intent was to make the specimens now designated *P. eurystoma* the types of the genus *Pseudoclimacograptus*. Each transitional step in the evolutionary development sequence has not been accorded a generic name here because to do so would magnify the position of one or two species that are clearly related to others within a genus comprised of a number of phyletically related species and give to them a greater magnitude in the taxonomic hierarchy than is warranted by the degree of their phyletic relationship.

Pseudoclimacograptus cf. **P. scharenbergi** (Lapworth 1876)

(Pl. 50, fig. 6, 7; Fig. 1)

LOCALITY: The Victorian specimens of this form were collected at Geological Survey of Victoria locality Ba 67 which is at the junction of Riddell's and Jackson's Creeks 6½ miles N. 86°E. from the centre of Gisborne, Victoria. The beds at that locality are in the Zone of *Glyptograptus teretiusculus*, the youngest of the Darriwilian zones. The type specimens of *P. scharenbergi* were obtained from the Lower Hartfell Shales (*Climacograptus wilsoni* Zone) exposed at Dobbs Linn near Moffat in southern Scotland.

MATERIAL: 5 specimens obtained by the author from locality Ba 67.

DESCRIPTION: The rhabdosomes are up to 15 mm long. They widen from 0·9 to 1·0 mm at the aperture of Th 1^1 to their maximum width of 1·4 to 1·5 mm in a distance of 4 to 6 mm from the sicula aperture. They are parallel-sided for

the remainder of their extent. A short virgula is present at the distal end of the thecate part of complete rhabdosomes.

The thecae number 7½ in the proximal 5 mm, 14 in the proximal 10 mm, and 6 in the distal 5 mm of the longest rhabdosomes. They are markedly alternate. Above the level of 5 mm from the sicula aperture, the thecae are 1·2 to 1·3 mm long and they overlap approximately one-third of their length. The suprageniculars portion of the ventral wall has marked convex curvature. The infrageniculars portions of the ventral walls are straight to slightly curved and make an angle of 55° to 70° with the rhabdosome axis. The geniculum is rounded. The apertural margins are straight and, in those thecae that have not been appreciably distorted, they are normal to the rhabdosome axis. The apertural excavations are 0·5 to 0·6 mm deep and slightly wedged-shaped, widening from 0·2 mm to 0·25 to 0·3 mm at the ventral margin of the rhabdosome. The interthecal septum parallels the suprageniculars portion of the ventral wall and has much the same degree of curvature. It bends sharply, however, in the vicinity of the geniculum to become horizontal and to end freely.

The sicula is at least 1 mm long and 0·2 to 0·3 mm wide at its aperture. It has a virgella that is 0·8 to 1·0 mm long. Th 1^1 appears to have originated from the upper third of the sicula and to have grown beside it for the greater part of its length, bending outward at the level of the sicula aperture and then upward for a short distance. The remainder of the proximal end development appears, as closely as may be seen from the specimens available, to be very similar to that diagrammed by Bulman (1955, p. 510, Fig. 1) in Oslo Region specimens of this species.

The median septum begins approximately at the level of the aperture of Th 1^2 and is zig-zag in shape throughout its extent. Projections 0·3 to 0·4 mm long extend horizontally from the angles of the median septum. The projections end freely and the lower part of the interthecal septum curves around them.

Remarks: The Victorian specimens agree relatively closely with Lapworth's (1876, Pl. 2, fig. 55; 1877, p. 138, Pl. 6, fig. 36) typical material of the species in rhabdosome width, thecal number, apertural excavation form and size, interthecal septum shape, median septum shape, and in the presence of short horizontal lists originating from the angles of the median septum that end freely. The suprageniculars portions of the ventral thecal walls are more markedly curved than in Scottish specimens. They are, however, relatively similar in curvature to that in Oslo Region, Norway, specimens included in this species by Bulman (1953, p. 510-511, Fig. 1; Pl. 1, fig. 1-7). The Victorian forms are closely similar to the Oslo Region specimens in most other characteristics as well. The Victorian specimens are shorter (this may simply be a reflection of immaturity of the rhabdosomes found) and slightly wider at Th 1^1 than the Oslo Region specimens. The apertural excavations in the Oslo Region specimens are slightly deeper than in the Victorian, and the suprageniculars portions of the thecal walls in the Oslo Region specimens may be slightly more curved than they are in the Victorian forms. The differences between the Oslo Region and Victorian specimens appear to be of no greater magnitude than those of local populations.

The Oslo Region and Victorian specimens are older than the type specimens from Scotland. The characteristic of marked curvature of the suprageniculars portion of the thecal walls may thus be a reflection of the age difference between the Oslo Region and Victorian and Scottish specimens. The Oslo Region and Victorian forms may comprise a temporal subspecies of *P. scharenbergi*, or they may, when full analysis of all forms referred to *P. scharenbergi* has been completed, be concluded to be a distinct species.

FIG. 1—*Pseudoclimacograptus* cf. *P. scharenbergi* (Lapworth). Specimen from Geological Survey of Victoria locality Ba 67, NMV P24028, × 10.

Family RETIOLITIDAE Lapworth 1873

Subfamily ARCHIRETIOLITINAE Bulman 1955

Genus **Retiograptus** J. Hall 1859

Retiograptus pulcherrimus Keble & Harris 1934

(Pl. 50, fig. 8)

1934 *Retiograptus pulcherrimus* Keble & Harris, p. 178-179, Fig. 6; Pl. 22, fig. 1.
1938 *Retiograptus pulcherrimus* Keble & Harris-Harris & Thomas, Pl. 3, fig. 106.
1960 *Retiograptus pulcherrimus* Keble & Harris-Thomas, Pl. 11, fig. 152.
1960b *Retiograptus pulcherrimus* Keble & Harris-Berry, p. 96, Pl. 17, fig. 9, 10b.
1963 *Retiograptus pulcherrimus* Keble & Harris-Ross & Berry, p. 158-59, Pl. 13, fig. 13, 13a, 14.
1964 *Retiograptus pulcherrimus* Keble & Harris-Obut & Sobolevskaya, p. 79, Pl. 16, fig. 8-11.

HOLOTYPE: NMV No. P14385.

TYPE LOCALITY AND HORIZON: Keble & Harris (1934, p. 179) gave the locality of the holotype as 'about 10 chains West of Jordan River where it runs under

Yarra Track between Matlock and The Oaks'. They cited the horizon as being in the Bolindian. It is probably in the Zone of *Dicellograptus* cf. *D. complanatus,* the youngest of the Australian Ordovician and the younger of the two zones of the Bolindian.

MATERIAL: The holotype and 2 probable topotypes.

DESCRIPTION: The rhabdosomes studied are incomplete but the longest is 85 mm. The rhabdosomes are 0·9 to 1·0 mm wide at the aperture of Th 1^1 and they widen to 1·7 to 1·8 mm at 5 mm from that level, to 2·2 to 2·35 mm at 10 mm from that level, and to 2·4 to 2·5 mm at 15 mm from that level. They continue to widen very slightly at the rate of 0·03 to 0·05 mm in 5 mm to a maximum width of 2·7 to 3·0 mm and they become parallel-sided for the remainder of their length after maximum width is attained. The rhabdosomes thus have a distinctive form in which the greatest rate of widening is in the proximal 10 mm and they continue to widen at a very slight rate until maximum width is attained and then become parallel-sided. All widths given are exclusive of the thecal spines.

The thecae are markedly alternate. They number 7 to 8 in the proximal 5 mm, 12 to 14 in the proximal 10 mm, and 7 to 10 in 10 mm in distal portions of the rhabdosome. The thecae are composed of two hexagonal-shaped meshes which appear to share a common strand that serves as the ventral thecal wall. The meshes are joined to a slightly undulatory list or fibre that extends vertically the length of the rhabdosome by a short horizontal projection from the angle formed at the join of two lists of the mesh. One such vertical list extends the length of and is situated in a medial position on both lateral walls of the rhabdosome. The ventral walls of the proximal thecae make a 25° to 35° angle with the rhabdosome axis and those of the distal thecae make a 5° to 10° angle with the rhabdosome axis. A horizontal spine projects from the lip of each thecal aperture. The spines are 0·45 to 0·7 mm long on the proximal thecae and 0·3 to 0·4 mm long on the distal thecae.

The sicula was not clearly seen on the specimens studied. It appears to be approximately 1 mm long and to be chitinized. Indeed, a thin periderm appears to cover the proximal end to the level of the aperture of Th 2^1, and it may extend slightly higher.

The rhabdosome is thus composed of elathria almost entirely with but a small amount of thin periderm at the proximal end. The elathria are formed in a double row of hexagonal-shaped meshes.

REMARKS: The length, rate of widening, and hexagonal-shaped meshes joined to undulatory vertical strands situated in the middle of the lateral walls make this species distinctive.

The Marathon Region, Texas specimens of it described by Berry (1960b) are similar to the Victorian types in most characteristics but are shorter and thinner as they widen to maximum widths of but 2·5 to 2·7 mm. The shape of the meshes and rate of widening are similar. The North American Great Basin forms described by Ross & Berry (1963) are also similar to the Victorian types in most characteristics. The Great Basin specimens, however, are longer than any reported from Victoria and have a maximum width of but 2·5 mm. Further, they attain maximum width in slightly more proximal portions of the rhabdosome than do the Victorian types and thus they are parallel-sided for a greater proportion of their length. The Great Basin forms may possibly be considered to constitute a subspecies distinct from one comprised of the Victorian types. Interestingly, the Marathon Region, Texas specimens are more similar to the Victorian types than they are to the Great Basin forms. The degree of difference between them and the Victorian types is not

as great as that between the Victorian types and the Great Basin forms and hence the Texas specimens may not fall within a possible subspecies comprised of Great Basin forms.

The Taimyr (Russian) specimens described by Obut & Sobolevskaya (1964) are also similar to the Victorian types in many characteristics but they are wider, attaining maximum widths of 3·5 to 3·7 mm. They also appear to have attained maximum width nearer the proximal end than did the Victorian types and hence they are parallel-sided for a greater proportion of their length than are the Victorian types. The Taimyr specimens also appear to comprise a possible subspecies which is distinct from that of the North American Great Basin forms and that of the Victorian types.

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Explanation of Plates

The photographs are not retouched. All of them, with the exception of fig. 2, 4, and 6 on Pl. 48, fig. 3 and 4 on Pl. 49, and fig. 1 through 7 on Pl. 50, were taken by Mr Frank Guy of the Royal Melbourne Institute of Technology. Those listed were taken at the Scientific Photographic Laboratory of the University of California, Berkeley.

All specimens figured are in the collections of the National Museum of Victoria. The numbers given each specimen are their registered numbers in the Museum's collections.

Locality and stratigraphic data for each species are given in the text under the discussion of each.

Plate 44

Fig. 1—*Adelograptus victoriae* (T. S. Hall), Lectotype, NMV P14240, × 4½.
Fig. 2, 4—*Adelograptus clarki* (T. S. Hall).
Fig. 2—Lectotype, NMV P14366, × 5·1.
Fig. 4—Topotype, on same rock piece with lectotype of *Adelograptus victoriae* which has NMV No. 14240, × 3.
Fig. 3—*Brachiograptus etaformis* Harris & Keble. Paratype, NMV P24020, × 4.
Fig. 5, 10, 11—*Tetragraptus decipiens* T. S. Hall.
Fig. 5—Lectotype, NMV P14368, × 5.
Fig. 10—Topotype, on same rock piece with *Didymograptus pritchardi* (three-branched form) which has NMV No. 14239, × 2½.
Fig. 11—Topotype, on same rock piece with lectotype of *Adelograptus victoriae* which has NMV No. P14240, × 3.
Fig. 6-9—*Phyllograptus nobilis* Harris & Keble. Topotypes, all specimens on same rock piece with NMV No. P24113. Fig. 6-8 × 3½, fig. 9 × 2·4.

Plate 45

Fig. 1—*Didymograptus pritchardi* T. S. Hall. Topotype, NMV P240, × 2.
Fig. 2—*Phyllograptus* cf. *P. nobilis* Harris & Keble. Specimen from Gibbo R, NE. Victoria

in which characteristic thecal curvature may be clearly seen, NMV P24031, × 4½.
Fig. 3—*Didymograptus dependulus* Harris & Keble. Holotype, NMV P24022, × 5.

PLATE 46

Fig. 1—*Didymograptus pritchardi* T. S. Hall. Lectotype, NMV P14238, × 3.
Fig. 2—*Didymograptus mundus* T. S. Hall. Holotype, NMV P14270, × 5.

PLATE 47

Fig. 1—*Didymograptus pritchardi* T. S. Hall. Proximal region of topotype, NMV P240, × 5.
Fig. 2—*Didymograptus pritchardi* T. S. Hall (Three-branched form). Proximal region of paratype from the same locality and horizon as the lectotype, NMV P14239, × 5½. (This is the specimen figured by Hall, 1899a, Pl. 17, fig. 9; Pl. 19, fig. 8.)

PLATE 48

Fig. 1—*Didymograptus v-deflexus* Harris. Holotype (the horizontal specimen) and paratypes, NMV P29, × 4.
Fig. 2, 4—*Orthograptus truncatus* var. *abbreviatus* (Elles & Wood). Both specimens on same rock piece with NMV No. P24025. Locality is Stockyard Ck, Wellesley County, New South Wales. Both specimens figured × 5.
Fig. 3, 5, 6—*Paraglossograptus etheridgei* (Harris).
Fig. 3—Paratype, NMV P14421, × 4.
Fig. 5—Holotype, NMV P14406, × 3½.
Fig. 6—Specimen from butts of Wellsford Rifle Range, Parish of Sandhurst, Victoria; the horizon is within the Zone of *Diplograptus decoratus* (D3 of the Darriwilian); NMV P24026, × 5.
(The characteristics of the spines are relatively clearly seen in these specimens. Note their variability in the holotype and the variation between those of the holotype and the paratype.)

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Fig. 1, 2, 7—*Diplograptus ingens* T. S. Hall
Fig. 1—Lectotype, NMV P14272, × 2½.
Fig. 2—Specimen on same rock piece as lectotype; the rock piece has NMV No. P14272, × 2½.
Fig. 7—Specimen on same rock piece as lectotype; the rock piece has NMV No. P14272, × 2.
Fig. 3, 4—*Climacograptus bicornis* subspecies *longispina* T. S. Hall.
Fig. 3—Topotype, NMV P24027, × 5.
Fig. 4—Topotype, NMV P24027 (on same rock piece with specimen of fig. 3), × 5.
Fig. 5, 6—*Didymograptus hemicyclus* Harris. Lectotype, NMV P13797, fig. 5 is × 5, fig. 6 is × 10.

PLATE 50

Fig. 1-5—*Climacograptus riddellensis* Harris. Topotypes from Geological Survey of Victoria Locality Ba 67 (junction of Riddell's and Jackson's creeks near Gisborne, Victoria).
Fig. 1, 2—NMV P24032. Fig. 1 is medial portion of rhabdosome × 10; fig. 2 is of complete rhabdosome, × 5.
Fig. 3—NMV P24033, × 5.
Fig. 4—NMV P24034, × 5, subscalariform view of incomplete rhabdosome.
Fig. 5—NMV P24035, × 5.
Fig. 6, 7—*Pseudoclimacograptus* cf. *P. scharenbergi* (Lapworth). Specimens from Geological Survey of Victoria Locality Ba 67.
Fig. 6—NMV P24028, × 10.
Fig. 7—NMV P24029, × 10.
Fig. 8—*Retiograptus pulcherrimus* Keble & Harris. Holotype, NMV P14385, × 4½.